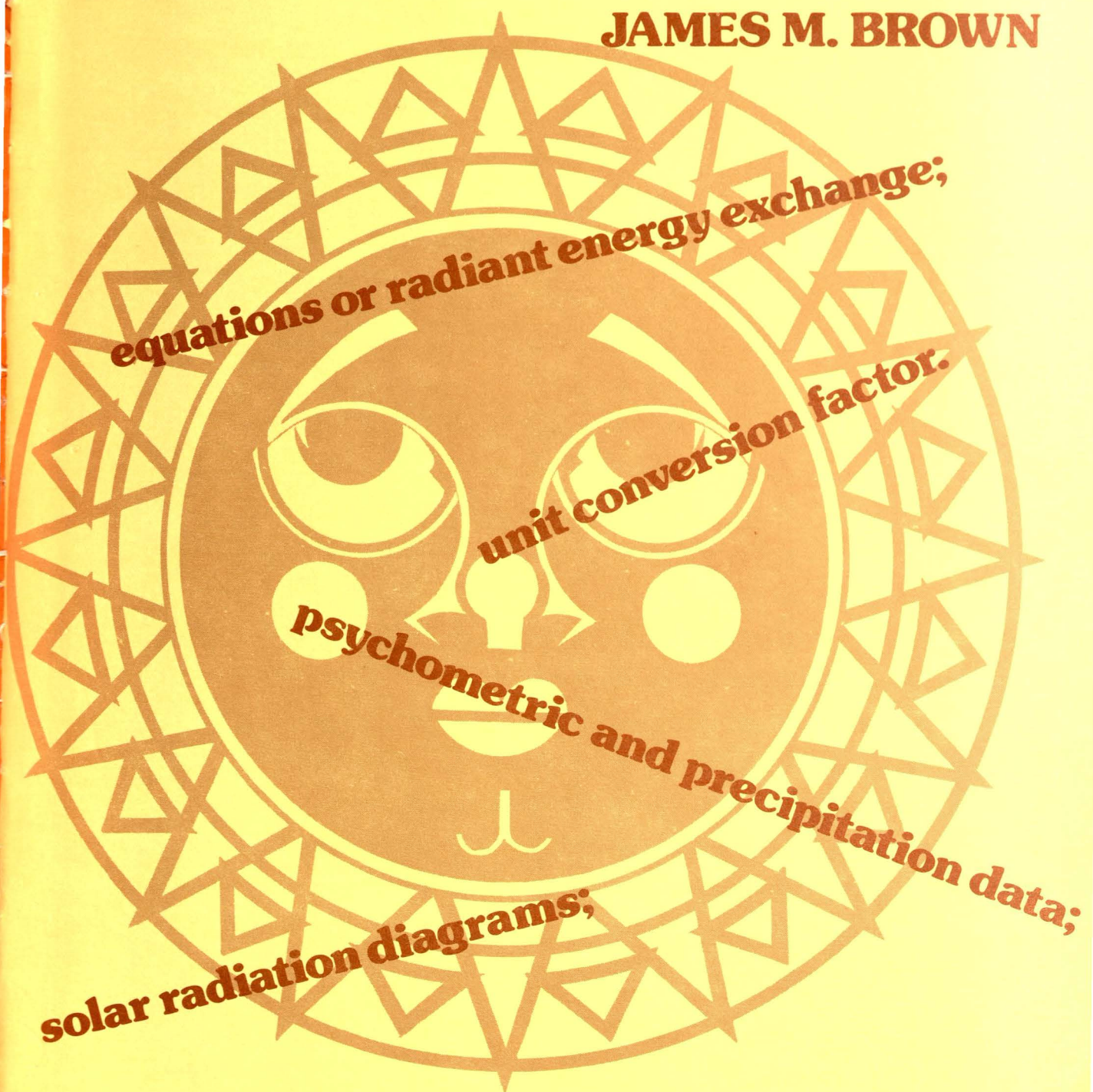


TABLES AND CONVERSIONS FOR MICROCLIMATOLOGY

JAMES M. BROWN



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1973. Tables and conversions for microclimatology. North Cent. For. Exp. Stn., St. Paul, Minn. 31 p., illus. (USDA For. Serv. Gen. Tech. Rep. NC-8)

A series of tables, charts, and conversion factors have been prepared for use in microclimatic and ecological studies. Included are: the solution to various equations of radiant energy exchange; solar radiation diagrams; psychometric and precipitation data; and unit conversion factors.

OXFORD: 111.84(083.5). KEY WORDS: meteorology, radiant energy, solar radiation, humidity, precipitation.

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INTRODUCTION

This collection of tables and conversion factors will aid climatologists, foresters, biologists, and others who are concerned with measuring and evaluating microclimate. Much of the material here has not been presented before, or has not been given with sufficient detail to serve as a useful reference. Other material is easily available but has been incorporated here to enhance the usefulness of this collection as a single source reference.

Unless otherwise noted, all constants used in the calculation of the tables and figures are from List (1968). The topic of solar beam irradiation on sloping surfaces has been omitted from this collection and the user is referred to the tables of Fons *et al.* (1960) and Frank and Lee (1966). The items within the lists of conversion factors are arranged alphabetically.

The author assumes full responsibility for any errors or inaccuracies and would appreciate having them called to his attention.

RADIANT ENERGY

Rate--Stefan-Boltzmann Law

Any substance warmer than absolute zero (-273.2°C) radiates energy at a rate directly proportional to the fourth power of its absolute temperature. For a perfect radiator, or "black body," the rate of radiant energy emission may be found by the Stefan-Boltzmann law:

$$W = \sigma T^4$$

where W is the rate of radiant energy emission ($\text{cal cm}^{-2} \text{ min}^{-1}$); σ is the Stefan-Boltzmann constant ($8.132 \times 10^{-11} \text{ cal cm}^{-2} \text{ min}^{-1} \text{ }^{\circ}\text{K}^{-4}$); and T is the absolute temperature ($^{\circ}\text{K}$) of the radiating surface.

Table 1 is the solution of the Stefan-Boltzmann equation for various temperatures in

degrees Centigrade, and tenths, and table 2 presents W values for Fahrenheit temperatures.

For less-than-perfect radiators, or "gray bodies," the rate of radiant energy emission may be found by multiplying the maximum or "black body" values by the appropriate emissivity factor.

Spectral Distribution--Planck's Law

The intensity of energy emitted by a black body at various wavelengths is described by Planck's law:

$$W\lambda = c_1 \lambda^{-5} \left(\exp \frac{c_2}{\lambda T} - 1 \right)^{-1}$$

where $W\lambda$ is the intensity of energy emitted at wavelength λ , c_1 and c_2 are constants, and T is the absolute temperature ($^{\circ}\text{K}$) of the black body source.

Tables 3 and 4 are solutions of Planck's law for a range of typical terrestrial temperatures, in degrees Centigrade. Table 3 gives values for $W\lambda$ in $\text{ergs cm}^{-2} \text{ sec}^{-1} \text{ cm}$ of wavelength $^{-1}$, where constant $c_1 = 3.740 \times 10^{-1} \text{ erg cm}^{-2} \text{ sec}^{-1}$ and $c_2 = 1.4835 \text{ cm }^{\circ}\text{K}$. In table 4 these values have been converted to give $W\lambda$ in $\text{cal cm}^{-2} \text{ min}^{-1} \text{ micron}$ of wavelength $^{-1}$.

Peak Intensity--Wien's Displacement Law

The wavelength of maximum emission may be found by Wien's displacement law:

$$\lambda_{\text{max}} = 2897 \text{ micron }^{\circ}\text{K T}^{-1}$$

where λ_{max} is the wavelength of maximum emission (microns), and T is the absolute temperature ($^{\circ}\text{K}$) of the radiating body.

Table 5 presents λ_{max} values for various temperatures. This table also includes the total energy radiated at these temperatures, the frequency of maximum emission (reciprocal of wavelength), and the intensity of the radiant energy flux at maximum emission.

Table 1.--Solution of the Stefan-Boltzmann law, $W = \sigma T^4$, for temperatures in degrees Centigrade. W is the rate of energy emission in $\text{cal cm}^{-2} \text{min}^{-1}$ for a black body

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
-40	0.2397	0.2393	0.2389	0.2384	0.2380	0.2376	0.2372	0.2368	0.2364	0.2360
-39	.2438	.2434	.2430	.2426	.2422	.2417	.2413	.2409	.2405	.2401
-38	.2480	.2476	.2472	.2467	.2463	.2459	.2455	.2451	.2446	.2442
-37	.2523	.2518	.2514	.2510	.2506	.2501	.2497	.2493	.2489	.2484
-36	.2566	.2561	.2557	.2553	.2548	.2544	.2540	.2535	.2531	.2527
-35	.2609	.2605	.2600	.2596	.2592	.2587	.2583	.2579	.2574	.2570
-34	.2653	.2649	.2644	.2640	.2636	.2631	.2627	.2622	.2618	.2614
-33	.2698	.2694	.2689	.2685	.2680	.2676	.2671	.2667	.2662	.2658
-32	.2743	.2739	.2734	.2730	.2725	.2721	.2716	.2712	.2707	.2703
-31	.2789	.2784	.2780	.2775	.2771	.2766	.2762	.2757	.2752	.2748
-30	.2835	.2831	.2826	.2821	.2817	.2812	.2808	.2803	.2798	.2794
-29	.2882	.2878	.2873	.2868	.2864	.2859	.2854	.2849	.2845	.2840
-28	.2930	.2925	.2920	.2916	.2911	.2906	.2901	.2897	.2892	.2887
-27	.2978	.2973	.2968	.2964	.2959	.2954	.2949	.2944	.2940	.2935
-26	.3027	.3022	.3017	.3012	.3007	.3002	.2998	.2993	.2988	.2983
-25	.3076	.3071	.3066	.3061	.3056	.3051	.3046	.3042	.3037	.3032
-24	.3126	.3121	.3116	.3111	.3106	.3101	.3096	.3091	.3086	.3081
-23	.3177	.3171	.3166	.3161	.3156	.3151	.3146	.3141	.3136	.3131
-22	.3228	.3223	.3217	.3212	.3207	.3202	.3197	.3192	.3187	.3182
-21	.3279	.3274	.3269	.3264	.3259	.3253	.3248	.3243	.3238	.3233
-20	.3332	.3327	.3321	.3316	.3311	.3306	.3300	.3295	.3290	.3285
-19	.3385	.3379	.3374	.3369	.3364	.3358	.3353	.3348	.3342	.3337
-18	.3438	.3433	.3428	.3422	.3417	.3412	.3406	.3401	.3395	.3390
-17	.3493	.3487	.3482	.3476	.3471	.3465	.3460	.3455	.3449	.3444
-16	.3548	.3542	.3537	.3531	.3526	.3520	.3515	.3509	.3504	.3498
-15	.3603	.3598	.3592	.3586	.3581	.3575	.3570	.3564	.3559	.3553
-14	.3659	.3654	.3648	.3642	.3637	.3631	.3625	.3620	.3614	.3609
-13	.3716	.3710	.3705	.3699	.3693	.3688	.3682	.3676	.3671	.3665
-12	.3774	.3768	.3762	.3756	.3751	.3745	.3739	.3733	.3728	.3722
-11	.3832	.3826	.3820	.3814	.3808	.3803	.3797	.3791	.3785	.3779
-10	.3891	.3885	.3879	.3873	.3867	.3861	.3855	.3849	.3844	.3838
-9	.3950	.3944	.3938	.3932	.3926	.3920	.3914	.3908	.3902	.3897
-8	.4010	.4004	.3998	.3992	.3986	.3980	.3974	.3968	.3962	.3956
-7	.4071	.4065	.4059	.4053	.4047	.4041	.4035	.4029	.4022	.4016
-6	.4133	.4127	.4120	.4114	.4108	.4102	.4096	.4090	.4083	.4077
-5	.4195	.4189	.4183	.4176	.4170	.4164	.4158	.4151	.4145	.4139
-4	.4258	.4252	.4245	.4239	.4233	.4226	.4220	.4214	.4208	.4201
-3	.4322	.4315	.4309	.4303	.4296	.4290	.4283	.4277	.4271	.4264
-2	.4386	.4380	.4373	.4367	.4360	.4354	.4347	.4341	.4334	.4328
-1	.4451	.4445	.4438	.4432	.4425	.4419	.4412	.4406	.4399	.4393
-0	.4517	.4510	.4504	.4497	.4491	.4484	.4477	.4471	.4464	.4458
+0	.4517	.4524	.4530	.4537	.4544	.4550	.4557	.4563	.4570	.4577
1	.4584	.4590	.4597	.4604	.4610	.4617	.4624	.4631	.4637	.4644
2	.4651	.4658	.4664	.4671	.4678	.4685	.4692	.4698	.4705	.4712
3	.4719	.4726	.4733	.4739	.4746	.4753	.4760	.4767	.4774	.4781
4	.4788	.4795	.4801	.4808	.4815	.4822	.4829	.4836	.4843	.4850
5	.4857	.4864	.4871	.4878	.4885	.4892	.4899	.4906	.4913	.4920
6	.4927	.4934	.4942	.4949	.4956	.4963	.4970	.4977	.4984	.4991
7	.4998	.5006	.5013	.5020	.5027	.5034	.5041	.5049	.5056	.5063
8	.5070	.5077	.5085	.5092	.5099	.5106	.5114	.5121	.5128	.5135
9	.5143	.5150	.5157	.5165	.5172	.5179	.5187	.5194	.5201	.5209
10	.5216	.5223	.5231	.5238	.5246	.5253	.5260	.5268	.5275	.5283
11	.5290	.5298	.5305	.5313	.5320	.5328	.5335	.5343	.5350	.5358
12	.5365	.5373	.5380	.5388	.5395	.5403	.5410	.5418	.5426	.5433
13	.5441	.5448	.5456	.5464	.5471	.5479	.5487	.5494	.5502	.5510

Continued on next page

Table 1 continued

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
14	.5517	.5525	.5533	.5540	.5548	.5556	.5564	.5571	.5579	.5587
15	.5595	.5602	.5610	.5618	.5626	.5634	.5641	.5649	.5657	.5665
16	.5673	.5681	.5688	.5696	.5704	.5712	.5720	.5728	.5736	.5744
17	.5752	.5760	.5767	.5775	.5783	.5791	.5799	.5807	.5815	.5823
18	.5831	.5839	.5847	.5855	.5863	.5872	.5880	.5888	.5896	.5904
19	.5912	.5920	.5928	.5936	.5944	.5953	.5961	.5969	.5977	.5985
20	.5993	.6002	.6010	.6018	.6026	.6034	.6043	.6051	.6059	.6067
21	.6076	.6084	.6092	.6100	.6109	.6117	.6125	.6134	.6142	.6150
22	.6159	.6167	.6175	.6184	.6192	.6201	.6209	.6217	.6226	.6234
23	.6243	.6251	.6259	.6268	.6276	.6285	.6293	.6302	.6310	.6319
24	.6327	.6336	.6344	.6353	.6362	.6370	.6379	.6387	.6396	.6404
25	.6413	.6422	.6430	.6439	.6448	.6456	.6465	.6473	.6482	.6491
26	.6500	.6508	.6517	.6526	.6534	.6543	.6552	.6561	.6569	.6578
27	.6587	.6596	.6605	.6613	.6622	.6631	.6640	.6649	.6657	.6666
28	.6675	.6684	.6693	.6702	.6711	.6720	.6729	.6737	.6746	.6755
29	.6764	.6773	.6782	.6791	.6800	.6809	.6818	.6827	.6836	.6845
30	.6854	.6863	.6872	.6882	.6891	.6900	.6909	.6918	.6927	.6936
31	.6945	.6954	.6964	.6973	.6982	.6991	.7000	.7010	.7019	.7028
32	.7037	.7046	.7056	.7065	.7074	.7083	.7093	.7102	.7111	.7121
33	.7130	.7139	.7149	.7158	.7167	.7177	.7186	.7195	.7205	.7214
34	.7224	.7233	.7242	.7252	.7261	.7271	.7280	.7290	.7299	.7309
35	.7318	.7328	.7337	.7347	.7356	.7366	.7375	.7385	.7394	.7404
36	.7414	.7423	.7433	.7442	.7452	.7462	.7471	.7481	.7491	.7500
37	.7510	.7520	.7529	.7539	.7549	.7559	.7568	.7578	.7588	.7598
38	.7607	.7617	.7627	.7637	.7647	.7656	.7666	.7676	.7686	.7696
39	.7706	.7716	.7726	.7735	.7745	.7755	.7765	.7775	.7785	.7795
40	.7805	.7815	.7825	.7835	.7845	.7855	.7865	.7875	.7885	.7895
41	.7905	.7915	.7925	.7936	.7946	.7956	.7966	.7976	.7986	.7996
42	.8006	.8017	.8027	.8037	.8047	.8057	.8068	.8078	.8088	.8098
43	.8109	.8119	.8129	.8139	.8150	.8160	.8170	.8181	.8191	.8201
44	.8212	.8222	.8232	.8243	.8253	.8264	.8274	.8284	.8295	.8305
45	.8316	.8326	.8337	.8347	.8358	.8368	.8379	.8389	.8400	.8410
46	.8421	.8431	.8442	.8453	.8463	.8474	.8484	.8495	.8506	.8516
47	.8527	.8538	.8548	.8559	.8570	.8580	.8591	.8602	.8613	.8623
48	.8634	.8645	.8656	.8666	.8677	.8688	.8699	.8710	.8721	.8731
49	.8742	.8753	.8764	.8775	.8786	.8797	.8808	.8818	.8829	.8840
50	.8851	.8862	.8873	.8884	.8895	.8906	.8917	.8928	.8939	.8950
51	.8961	.8973	.8984	.8995	.9006	.9017	.9028	.9039	.9050	.9061
52	.9073	.9084	.9095	.9106	.9117	.9129	.9140	.9151	.9162	.9173
53	.9185	.9196	.9207	.9219	.9230	.9241	.9253	.9264	.9275	.9287
54	.9298	.9309	.9321	.9332	.9344	.9355	.9366	.9378	.9389	.9401
55	.9412	.9424	.9435	.9447	.9458	.9470	.9481	.9493	.9504	.9516
56	.9528	.9539	.9551	.9562	.9574	.9586	.9597	.9609	.9621	.9632
57	.9644	.9656	.9667	.9679	.9691	.9702	.9714	.9726	.9738	.9750
58	.9761	.9773	.9785	.9797	.9809	.9820	.9832	.9844	.9856	.9868
59	.9880	.9892	.9904	.9916	.9928	.9939	.9951	.9963	.9975	.9987
60	.9999	1.0011	1.0023	1.0035	1.0048	1.0060	1.0072	1.0084	1.0096	1.0108
61	1.0120	1.0132	1.0144	1.0156	1.0169	1.0181	1.0193	1.0205	1.0217	1.0230
62	1.0242	1.0254	1.0266	1.0279	1.0291	1.0303	1.0315	1.0328	1.0340	1.0352
63	1.0365	1.0377	1.0389	1.0402	1.0414	1.0426	1.0439	1.0451	1.0464	1.0476
64	1.0489	1.0501	1.0514	1.0526	1.0538	1.0551	1.0563	1.0576	1.0589	1.0601
65	1.0614	1.0626	1.0639	1.0651	1.0664	1.0677	1.0689	1.0702	1.0714	1.0727
66	1.0740	1.0752	1.0765	1.0778	1.0791	1.0803	1.0816	1.0829	1.0842	1.0854
67	1.0867	1.0880	1.0893	1.0905	1.0918	1.0931	1.0944	1.0957	1.0970	1.0983
68	1.0995	1.1008	1.1021	1.1034	1.1047	1.1060	1.1073	1.1086	1.1099	1.1112

Continued on next page

Table 1 continued

°C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
69	1.1125	1.1138	1.1151	1.1164	1.1177	1.1190	1.1203	1.1216	1.1230	1.1243
70	1.1256	1.1269	1.1282	1.1295	1.1308	1.1322	1.1335	1.1348	1.1361	1.1374
71	1.1388	1.1401	1.1414	1.1427	1.1441	1.1454	1.1467	1.1481	1.1494	1.1507
72	1.1521	1.1534	1.1547	1.1561	1.1574	1.1587	1.1601	1.1614	1.1628	1.1641
73	1.1655	1.1668	1.1682	1.1695	1.1709	1.1722	1.1736	1.1749	1.1763	1.1776
74	1.1790	1.1804	1.1817	1.1831	1.1844	1.1858	1.1872	1.1885	1.1899	1.1913
75	1.1927	1.1940	1.1954	1.1968	1.1981	1.1995	1.2009	1.2023	1.2037	1.2050
76	1.2064	1.2078	1.2092	1.2106	1.2120	1.2133	1.2147	1.2161	1.2175	1.2189
77	1.2203	1.2217	1.2231	1.2245	1.2259	1.2273	1.2287	1.2301	1.2315	1.2329
78	1.2343	1.2357	1.2371	1.2385	1.2400	1.2414	1.2428	1.2442	1.2456	1.2470
79	1.2484	1.2499	1.2513	1.2527	1.2541	1.2555	1.2570	1.2584	1.2598	1.2613
80	1.2627	1.2641	1.2656	1.2670	1.2684	1.2699	1.2713	1.2727	1.2742	1.2756
81	1.2771	1.2785	1.2799	1.2814	1.2828	1.2843	1.2857	1.2872	1.2886	1.2901
82	1.2915	1.2930	1.2945	1.2959	1.2974	1.2988	1.3003	1.3018	1.3032	1.3047
83	1.3062	1.3076	1.3091	1.3106	1.3120	1.3135	1.3150	1.3165	1.3179	1.3194
84	1.3201	1.3224	1.3239	1.3253	1.3268	1.3283	1.3298	1.3313	1.3328	1.3343
85	1.3358	1.3373	1.3388	1.3402	1.3417	1.3432	1.3447	1.3462	1.3477	1.3492
86	1.3508	1.3523	1.3538	1.3553	1.3568	1.3583	1.3598	1.3613	1.3628	1.3643
87	1.3659	1.3674	1.3689	1.3704	1.3719	1.3735	1.3750	1.3765	1.3780	1.3796
88	1.3811	1.3826	1.3842	1.3857	1.3872	1.3888	1.3903	1.3918	1.3934	1.3949
89	1.3965	1.3980	1.3996	1.4011	1.4027	1.4042	1.4058	1.4073	1.4089	1.4104
90	1.4120	1.4135	1.4151	1.4166	1.4182	1.4198	1.4213	1.4229	1.4244	1.4260
91	1.4276	1.4292	1.4307	1.4323	1.4339	1.4354	1.4370	1.4386	1.4402	1.4418
92	1.4433	1.4449	1.4465	1.4481	1.4497	1.4513	1.4529	1.4544	1.4560	1.4576
93	1.4592	1.4608	1.4624	1.4640	1.4656	1.4672	1.4688	1.4704	1.4720	1.4736
94	1.4752	1.4768	1.4785	1.4801	1.4817	1.4833	1.4849	1.4865	1.4881	1.4898
95	1.4914	1.4930	1.4946	1.4963	1.4979	1.4995	1.5011	1.5028	1.5044	1.5060
96	1.5077	1.5093	1.5109	1.5126	1.5142	1.5158	1.5175	1.5191	1.5208	1.5224
97	1.5241	1.5257	1.5274	1.5290	1.5307	1.5323	1.5340	1.5356	1.5373	1.5390
98	1.5406	1.5423	1.5439	1.5456	1.5473	1.5489	1.5506	1.5523	1.5539	1.5556
99	1.5573	1.5590	1.5606	1.5623	1.5640	1.5657	1.5674	1.5690	1.5707	1.5724
100	1.5741	1.5758	1.5775	1.5792	1.5809	1.5826	1.5843	1.5860	1.5876	1.5893

Table 2.--Solution of the Stefan-Boltzmann law, $W = \sigma T^4$, for temperatures in degrees Fahrenheit. W is the rate of energy emission in cal cm⁻² min⁻¹ for a black body

°F	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
-30	0.2635	0.2611	0.2586	0.2562	0.2538	0.2515	0.2491	0.2468	0.2444	0.2421
-20	.2889	.2863	.2837	.2811	.2785	.2760	.2735	.2709	.2685	.2660
-10	.3161	.3133	.3105	.3077	.3050	.3023	.2996	.2969	.2942	.2915
-0	.3451	.3421	.3392	.3362	.3333	.3304	.3275	.3246	.3217	.3189
+0	.3451	.3481	.3512	.3542	.3573	.3604	.3635	.3666	.3698	.3730
10	.3762	.3794	.3826	.3858	.3891	.3924	.3957	.3991	.4024	.4058
20	.4092	.4126	.4161	.4195	.4230	.4265	.4301	.4336	.4372	.4408
30	.4444	.4480	.4517	.4554	.4591	.4628	.4666	.4703	.4741	.4780
40	.4818	.4857	.4896	.4935	.4974	.5014	.5054	.5094	.5134	.5175
50	.5215	.5256	.5298	.5339	.5381	.5423	.5465	.5508	.5550	.5593
60	.5637	.5680	.5724	.5768	.5812	.5857	.5901	.5946	.5992	.6037
70	.6083	.6129	.6175	.6222	.6269	.6316	.6363	.6411	.6459	.6507
80	.6555	.6604	.6653	.6702	.6752	.6802	.6852	.6902	.6953	.7004
90	.7055	.7106	.7158	.7210	.7262	.7315	.7368	.7421	.7474	.7528
100	.7582	.7636	.7691	.7746	.7801	.7857	.7912	.7968	.8025	.8081
110	.8138	.8196	.8253	.8311	.8369	.8428	.8487	.8546	.8605	.8665
120	.8725	.8785	.8846	.8907	.8968	.9030	.9092	.9154	.9216	.9279
130	.9342	.9406	.9470	.9534	.9598	.9663	.9728	.9794	.9860	.9926
140	.9992	1.0059	1.0126	1.0194	1.0261	1.0330	1.0398	1.0467	1.0536	1.0605
150	1.0675	1.0746	1.0816	1.0887	1.0958	1.1030	1.1102	1.1174	1.1247	1.1320
160	1.1393	1.1467	1.1541	1.1615	1.1690	1.1765	1.1840	1.1916	1.1992	1.2069
170	1.2146	1.2223	1.2301	1.2379	1.2457	1.2536	1.2615	1.2695	1.2775	1.2855
180	1.2936	1.3017	1.3098	1.3180	1.3262	1.3345	1.3428	1.3511	1.3595	1.3679
190	1.3764	1.3849	1.3934	1.4020	1.4106	1.4192	1.4279	1.4366	1.4454	1.4542

Table 3.--Solution of Planck's law, $W\lambda = c_1\lambda^{-5} (\exp \frac{c_2}{\lambda T} - 1)^{-1}$, for temperatures in degrees C and wavelengths in cm. $W\lambda$ is the intensity of black body emission in $\text{ergs cm}^{-2} \text{sec}^{-1} \text{cm of wavelength}^{-1}$

Wave-length (cm)	Wave number cm ⁻¹	Temperature (°C)													
		-10	0	10	20	30	40	50	60	70	80	90	100	x	
0.0002	5,000.00	0.0006	0.0019	0.0048	0.0118	0.0273	0.0597	0.1243	0.2477	0.4742	0.8750	1.5610	2.6997	10 ⁵	
.0004	2,500.00	.0274	.0460	.0743	.1162	.1765	.2610	.3766	.5317	.7357	.9994	1.3348	1.7555	10 ⁸	
.0006	1,666.67	.3975	.5609	.7724	1.0408	1.3752	1.7850	2.2797	2.8693	3.5632	4.3712	5.3025	6.3663	10 ⁸	
.0008	1,250.00	.9900	1.2822	1.6304	2.0398	2.5146	3.0591	3.6770	4.3715	5.1455	6.0016	6.9418	7.9679	10 ⁸	
.0010	1,000.00	1.3326	1.6398	1.9888	2.3809	2.8171	3.2983	3.8250	4.3973	5.0154	5.6790	6.3880	7.1418	10 ⁸	
.0012	833.33	1.3788	1.6407	1.9290	2.2438	2.5848	2.9518	3.3443	3.7618	4.2039	4.6698	5.1590	5.6709	10 ⁸	
.0014	714.29	1.2596	1.4641	1.6846	1.9205	2.1716	2.4373	2.7172	3.0107	3.3173	3.6366	3.9680	4.3110	10 ⁸	
.0016	625.00	1.0819	1.2362	1.3999	1.5729	1.7546	1.9446	2.1426	2.3482	2.5610	2.7807	3.0070	3.2395	10 ⁸	
.0018	555.56	.9014	1.0166	1.1376	1.2641	1.3958	1.5322	1.6734	1.8190	1.9686	2.1221	2.2793	2.4400	10 ⁸	
.0020	500.00	.7405	.8268	.9167	1.0099	1.1062	1.2055	1.3075	1.4121	1.5192	1.6286	1.7401	1.8536	10 ⁸	
.0030	333.33	.2771	.3007	.3247	.3492	.3741	.3993	.4249	.4507	.4768	.5032	.5298	.5566	10 ⁸	
.0040	250.00	.1179	.1264	.1349	.1435	.1521	.1609	.1697	.1785	.1875	.1964	.2054	.2145	10 ⁸	
.0050	200.00	.5727	.6091	.6458	.6828	.7199	.7573	.7948	.8325	.8704	.9084	.9465	.9847	10 ⁷	
.0060	166.67	.3083	.3264	.3446	.3629	.3813	.3997	.4182	.4368	.4554	.4740	.4927	.5115	10 ⁷	
.0070	142.86	.1797	.1896	.1996	.2097	.2198	.2298	.2400	.2501	.2603	.2705	.2807	.2909	10 ⁷	
.0080	125.00	.1115	.1174	.1233	.1293	.1352	.1412	.1472	.1532	.1592	.1652	.1712	.1772	10 ⁷	
.0090	111.11	.7267	.7640	.8013	.8387	.8762	.9137	.9512	.9889	1.0266	1.0643	1.1020	1.1398	10 ⁶	
.0100	100.00	.4935	.5181	.5427	.5674	.5921	.6168	.6416	.6664	.6912	.7160	.7408	.7657	10 ⁶	
.1000	10.00	.6445	.6697	.6949	.7201	.7453	.7705	.7957	.8210	.8412	.8714	.8966	.9218	10 ²	

Table 4.--Solution of Planck's law, $W\lambda = c_1\lambda^{-5} (\exp \frac{c_2}{\lambda T} - 1)^{-1}$, for temperatures in degrees C and wavelengths in microns. $W\lambda$ is the intensity of black body emission in $\text{cal cm}^{-2} \text{min}^{-1} \text{micron}^{-1}$

Wave-length (microns)	Wave number μ^{-1}	Temperature ($^{\circ}\text{C}$)												
		-10	0	10	20	30	40	50	60	70	80	90	100	x
2	0.5000	0.0010	0.0027	0.0069	0.0170	0.0391	0.0855	0.1782	0.3551	0.6797	1.2543	2.2377	3.8701	10^{-5}
4	.2500	.0393	.0659	.1065	.1666	.2530	.3741	.5399	.7622	1.0546	1.4326	1.9135	2.5165	10^{-2}
6	.1667	.5698	.8041	1.1073	1.4921	1.9714	2.5588	3.2680	4.1131	5.1080	6.2662	7.6013	9.1262	10^{-2}
8	.1250	.1419	.1838	.2337	.2924	.3605	.4385	.5271	.6267	.7376	.8603	.9951	1.1422	10^{-1}
10	.1000	.1910	.2351	.2851	.3413	.4038	.4728	.5483	.6304	.7190	.8141	.9157	1.0238	10^{-1}
12	.0833	.1977	.2352	.2765	.3217	.3705	.4232	.4794	.5393	.6026	.6694	.7396	.8129	10^{-1}
14	.0714	.1806	.2099	.2415	.2753	.3113	.3494	.3895	.4316	.4755	.5213	.5688	.6180	10^{-1}
16	.0625	.1551	.1772	.2007	.2255	.2515	.2788	.3072	.3366	.3671	.3986	.4311	.4644	10^{-1}
18	.0556	.1292	.1457	.1631	.1812	.2001	.2197	.2399	.2608	.2822	.3042	.3267	.3498	10^{-1}
20	.0500	.1062	.1185	.1314	.1448	.1586	.1728	.1874	.2024	.2178	.2335	.2495	.2657	10^{-1}
30	.0333	.3972	.4311	.4555	.5006	.5363	.5724	.6091	.6461	.6835	.7214	.7595	.7979	10^{-2}
40	.0250	.1690	.1812	.1934	.2057	.2180	.2307	.2433	.2559	.2688	.2815	.2945	.3075	10^{-2}
50	.0200	.8210	.8732	.9258	.9788	1.0321	1.0856	1.1394	1.1934	1.2477	1.3021	1.3568	1.4116	10^{-3}
60	.0167	.4420	.4679	.4940	.5202	.5466	.5730	.5995	.6261	.6528	.6795	.7063	.7333	10^{-3}
70	.0143	.2576	.2719	.2860	.3006	.3150	.3295	.3440	.3585	.3731	.3877	.4023	.4170	10^{-3}
80	.0125	.1598	.1683	.1768	.1853	.1938	.2024	.2110	.2196	.2282	.2368	.2454	.2541	10^{-3}
90	.0111	.1042	.1095	.1149	.1202	.1256	.1310	.1364	.1418	.1472	.1526	.1580	.1634	10^{-3}
100	.0100	.7074	.7427	.7780	.8134	.8488	.8842	.9198	.9553	.9909	1.0264	1.0620	1.0977	10^{-4}
1,000	.0010	.9239	.9600	.9962	1.0323	1.0685	1.1046	1.1407	1.1769	1.2130	1.2491	1.2852	1.3214	10^{-8}

Table 5.--Total radiant energy (W), wave number ($\tilde{\nu}$) and wavelength (λ) of maximum emission, and intensity of maximum emission ($W_{\max}$) from a black body source

Temperature: (°C)	W	$\tilde{\nu}_{\max}$	$\lambda_{\max}$	$W_{\max}$	$W_{\max}$
	$\text{Cal cm}^{-2} \text{ min}^{-1}$	Wave number cm^{-1}	μ	$\text{Erg cm}^{-2} \text{ sec}^{-1} \text{ cm}^{-1} \times 10^7$	$\text{Cal cm}^{-2} \text{ min}^{-1} \mu^{-1} \times 10^{-1}$
-40	0.2397	804.3	12.4335	7.5608	0.1084
-39	.2438	807.7	12.3803	7.7245	.1107
-38	.2480	811.2	12.3277	7.8909	.1131
-37	.2523	814.6	12.2754	8.0602	.1155
-36	.2566	818.1	12.2236	8.2325	.1180
-35	.2609	821.5	12.1723	8.4076	.1205
-34	.2653	825.0	12.1213	8.5857	.1231
-33	.2698	828.4	12.0708	8.7669	.1257
-32	.2743	831.9	12.0207	8.9510	.1283
-31	.2789	835.3	11.9711	9.1383	.1310
-30	.2835	838.8	11.9218	9.3287	.1337
-29	.2882	842.3	11.8730	9.5222	.1365
-28	.2930	845.7	11.8245	9.7189	.1393
-27	.2978	849.2	11.7764	9.9189	.1422
-26	.3027	852.6	11.7287	10.1222	.1451
-25	.3076	856.1	11.6815	10.3287	.1481
-24	.3126	859.5	11.6345	10.5386	.1511
-23	.3177	863.0	11.5880	10.7520	.1541
-22	.3228	866.4	11.5418	10.9687	.1572
-21	.3279	869.9	11.4960	11.1890	.1604
-20	.3332	873.3	11.4506	11.4128	.1636
-19	.3385	876.8	11.4055	11.6401	.1669
-18	.3438	880.2	11.3608	11.8711	.1702
-17	.3493	883.7	11.3164	12.1057	.1735
-16	.3548	887.1	11.2724	12.3440	.1770
-15	.3603	890.6	11.2287	12.5860	.1804
-14	.3659	894.0	11.1853	12.8318	.1839
-13	.3716	897.5	11.1423	13.0814	.1875
-12	.3774	900.9	11.0996	13.3350	.1912
-11	.3832	904.4	11.0573	13.5924	.1948
-10	.3891	907.8	11.0152	13.8537	.1986
-9	.3950	911.3	10.9735	14.1191	.2024
-8	.4010	914.7	10.9321	14.3886	.2063
-7	.4071	918.2	10.8910	14.6621	.2102
-6	.4133	921.6	10.8502	14.9398	.2142
-5	.4195	925.1	10.8097	15.2217	.2182
-4	.4258	928.5	10.7695	15.5078	.2223
-3	.4322	932.0	10.7296	15.7982	.2265
-2	.4386	935.5	10.6900	16.0929	.2307
-1	.4451	938.9	10.6507	16.3920	.2350
0	.4517	942.4	10.6117	16.6956	.2393
1	.4584	945.8	10.5730	17.0036	.2437
2	.4651	949.3	10.5345	17.3162	.2482
3	.4719	952.7	10.4964	17.6333	.2528
4	.4788	956.2	10.4585	17.9551	.2574
5	.4857	959.6	10.4209	18.2815	.2621
6	.4927	963.1	10.3835	18.6127	.2668
7	.4998	966.5	10.3464	18.9487	.2716
8	.5070	970.0	10.3096	19.2895	.2765
9	.5143	973.4	10.2730	19.6351	.2815

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Table 5 continued

Temperature : (°C) :	W :	ν max :	λ max :	$W_{\max}$:	$W_{\max}$:
	$\text{cm}^{-2} \text{ min}^{-1}$	Wave number cm^{-1}	μ	Erg cm^{-2} $\text{sec}^{-1} \text{ cm}^{-1}$ $\times 10^7$	Cal cm^{-2} $\text{min}^{-1} \text{ y}^{-1}$ $\times 10^{-1}$
10	0.5216	976.9	10.2367	19.9858	0.2865
11	.5290	980.3	10.2007	20.3414	.2916
12	.5365	983.8	10.1649	20.7020	.2968
13	.5441	987.2	10.1294	21.0678	.3020
14	.5517	990.7	10.0941	21.4387	.3073
15	.5595	994.1	10.0590	21.8148	.3127
16	.5673	997.6	10.0242	22.1961	.3182
17	.5752	1,001.0	9.9897	22.5829	.3237
18	.5831	1,004.5	9.9553	22.9749	.3293
19	.5912	1,007.9	9.9212	23.3724	.3350
20	.5993	1,011.4	9.8874	23.7753	.3408
21	.6076	1,014.8	9.8537	24.1838	.3467
22	.6159	1,018.3	9.8203	24.5979	.3526
23	.6243	1,021.7	9.7872	25.0177	.3586
24	.6327	1,025.2	9.7542	25.4431	.3647
25	.6413	1,028.7	9.7215	25.8744	.3709
26	.6500	1,032.1	9.6890	26.3115	.3772
27	.6587	1,035.6	9.6567	26.7544	.3835
28	.6675	1,039.0	9.6246	27.2033	.3900
29	.6764	1,042.5	9.5927	27.6582	.3965
30	.6854	1,045.9	9.5611	28.1191	.4031
31	.6945	1,049.4	9.5296	28.5862	.4098
32	.7037	1,052.8	9.4984	29.0595	.4166
33	.7130	1,056.3	9.4673	29.5390	.4234
34	.7224	1,059.7	9.4365	30.0248	.4304
35	.7318	1,063.2	9.4058	30.5170	.4375
36	.7414	1,066.6	9.3754	31.0157	.4446
37	.7510	1,070.1	9.3452	31.5208	.4519
38	.7607	1,073.5	9.3151	32.0325	.4592
39	.7706	1,077.0	9.2853	32.5508	.4666
40	.7805	1,080.4	9.2556	33.0758	.4741
41	.7905	1,083.9	9.2261	33.6075	.4818
42	.8006	1,087.3	9.1968	34.1461	.4895
43	.8109	1,090.8	9.1677	34.6916	.4973
44	.8212	1,094.2	9.1388	35.2440	.5052
45	.8316	1,097.7	9.1101	35.8034	.5132
46	.8421	1,101.1	9.0815	36.3699	.5214
47	.8527	1,104.6	9.0531	36.9435	.5296
48	.8634	1,108.0	9.0249	37.5244	.5379
49	.8742	1,111.5	8.9969	38.1125	.5464
50	.8851	1,114.9	8.9690	38.7080	.5549
51	.8961	1,118.4	8.9414	39.3110	.5635
52	.9073	1,121.9	8.9138	39.9213	.5723
53	.9185	1,125.3	8.8865	40.5393	.5811
54	.9298	1,128.5	8.8593	41.1649	.5901
55	.9412	1,132.2	8.8323	41.7982	.5992
56	.9528	1,135.7	8.8055	42.4393	.6084
57	.9644	1,139.1	8.7788	43.0882	.6177
58	.9761	1,142.6	8.7523	43.7450	.6271
59	.9880	1,146.0	8.7259	44.4098	.6366

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Table 5 continued

Temperature (°C)	W	ν max	λ max	$W_{\max}$	$W_{\max}$
	$\frac{\text{Cal}}{\text{cm}^2 \text{ min}^{-1}}$	$\frac{\text{Wave number}}{\text{cm}^{-1}}$	μ	$\frac{\text{Erg}}{\text{sec}^{-1} \text{ cm}^{-2}} \times 10^7$	$\frac{\text{Cal}}{\text{min}^{-1} \text{ cm}^{-2}} \times 10^{-1}$
60	0.9999	1,149.5	8.6997	45.0827	0.6463
61	1.0120	1,152.9	8.6737	45.7637	.6560
62	1.0242	1,156.4	8.6478	46.4529	.6659
63	1.0365	1,159.8	8.6220	47.1503	.6759
64	1.0489	1,163.3	8.5964	47.8562	.6860
65	1.0614	1,166.7	8.5710	48.5704	.6963
66	1.0740	1,170.2	8.5457	49.2932	.7066
67	1.0867	1,173.6	8.5206	50.0246	.7171
68	1.0995	1,177.1	8.4956	50.7645	.7277
69	1.1125	1,180.5	8.4708	51.5133	.7385
70	1.1256	1,184.0	8.4461	52.2708	.7493
71	1.1388	1,187.4	8.4215	53.0372	.7603
72	1.1521	1,190.9	8.3971	53.8126	.7714
73	1.1655	1,194.3	8.3728	54.5970	.7827
74	1.1790	1,197.8	8.3487	55.3906	.7940
75	1.1927	1,201.2	8.3247	56.1933	.8055
76	1.2064	1,204.7	8.3009	57.0054	.8172
77	1.2203	1,208.1	8.2771	57.8267	.8290
78	1.2343	1,211.6	8.2536	58.6576	.8409
79	1.2484	1,215.1	8.2301	59.4979	.8529
80	1.2627	1,218.5	8.2068	60.3479	.8651
81	1.2771	1,222.0	8.1836	61.2075	.8774
82	1.2915	1,225.4	8.1606	62.0770	.8899
83	1.3062	1,228.9	8.1376	62.9561	.9025
84	1.3209	1,232.3	8.1148	63.8454	.9152
85	1.3358	1,235.8	8.0922	64.7446	.9281
86	1.3508	1,239.2	8.0696	65.6539	.9412
87	1.3659	1,242.7	8.0472	66.5734	.9543
88	1.3811	1,246.1	8.0249	67.5032	.9677
89	1.3965	1,249.6	8.0028	68.4434	.9812
90	1.4120	1,253.0	7.9807	69.3939	.9948
91	1.4276	1,256.5	7.9588	70.3551	1.0086
92	1.4433	1,260.0	7.9370	71.3268	1.0225
93	1.4592	1,263.4	7.9153	72.3093	1.0366
94	1.4752	1,266.8	7.8937	73.3025	1.0508
95	1.4914	1,270.3	7.8723	74.3067	1.0652
96	1.5077	1,273.7	7.8509	75.3217	1.0798
97	1.5241	1,277.2	7.8297	76.3479	1.0945
98	1.5406	1,280.6	7.8086	77.3852	1.1093
99	1.5573	1,284.1	7.7876	78.4338	1.1244
100	1.5741	1,287.5	7.7668	79.4937	1.1396

Atmospheric Radiation--Empirical Formulas

Empirical equations for estimating clear-sky atmospheric radiation differ primarily on the inclusion of a water vapor factor. Table 6 presents the Brunt equation, which includes a water vapor factor:

$$I_{\downarrow} = \sigma T^4 (a + b\sqrt{e})$$

where $I_{\downarrow}$ is the long-wave sky radiation in $\text{cal cm}^{-2} \text{ min}^{-1}$, σ is the Stefan-Boltzmann constant ($8.132 \times 10^{-11} \text{ cal cm}^{-2} \text{ min}^{-1} \text{ }^{\circ}\text{K}^{-4}$), T is the screen-height air temperature ($^{\circ}\text{K}$), a and b are constants with values of 0.660 and 0.039 respectively, and e is the screen-height vapor pressure in millibars. The values in table 6 are presented in terms of screen-height air temperature in $^{\circ}\text{C}$ and screen-height relative humidity.

Table 6.--*Brunt equation, $I\downarrow = \sigma T^4 (a + b\sqrt{e})$, for atmospheric radiation*

(In $\text{cal cm}^{-2} \text{ min}^{-1}$)

°C	Percent relative humidity											
	100	90	80	70	60	50	40	30	20	10	1	
-40	0.1622	0.1620	0.1618	0.1616	0.1613	0.1611	0.1608	0.1604	0.1600	0.1595	0.1586	
-39	.1653	.1650	.1648	.1646	.1643	.1640	.1637	.1633	.1629	.1623	.1614	
-38	.1683	.1681	.1679	.1676	.1673	.1670	.1666	.1662	.1658	.1652	.1642	
-37	.1715	.1712	.1710	.1707	.1704	.1700	.1696	.1692	.1687	.1681	.1670	
-36	.1747	.1744	.1741	.1738	.1735	.1731	.1727	.1723	.1717	.1710	.1699	
-35	.1779	.1776	.1773	.1770	.1766	.1762	.1758	.1753	.1748	.1740	.1728	
-34	.1812	.1809	.1806	.1802	.1798	.1794	.1790	.1785	.1778	.1770	.1757	
-33	.1846	.1842	.1839	.1835	.1831	.1827	.1822	.1816	.1810	.1801	.1787	
-32	.1880	.1876	.1873	.1869	.1864	.1860	.1854	.1849	.1842	.1832	.1817	
-31	.1915	.1911	.1907	.1903	.1898	.1893	.1888	.1881	.1874	.1864	.1848	
-30	.1950	.1946	.1942	.1937	.1933	.1927	.1921	.1915	.1907	.1896	.1879	
-29	.1986	.1982	.1978	.1973	.1967	.1962	.1956	.1948	.1940	.1929	.1911	
-28	.2023	.2019	.2014	.2009	.2003	.1997	.1990	.1983	.1974	.1962	.1943	
-27	.2061	.2056	.2051	.2045	.2039	.2033	.2026	.2018	.2008	.1996	.1975	
-26	.2099	.2094	.2088	.2082	.2076	.2069	.2062	.2053	.2043	.2030	.2008	
-25	.2138	.2132	.2127	.2120	.2114	.2106	.2098	.2089	.2078	.2064	.2041	
-24	.2178	.2172	.2166	.2159	.2152	.2144	.2136	.2126	.2114	.2099	.2075	
-23	.2218	.2212	.2205	.2198	.2191	.2183	.2174	.2163	.2151	.2135	.2109	
-22	.2259	.2253	.2246	.2238	.2230	.2222	.2212	.2201	.2188	.2171	.2143	
-21	.2302	.2295	.2287	.2279	.2271	.2261	.2251	.2240	.2226	.2208	.2178	
-20	.2345	.2337	.2323	.2321	.2312	.2302	.2291	.2279	.2264	.2245	.2214	
-19	.2388	.2380	.2372	.2363	.2353	.2343	.2332	.2318	.2303	.2283	.2249	
-18	.2433	.2425	.2416	.2406	.2396	.2385	.2373	.2359	.2342	.2321	.2286	
-17	.2478	.2470	.2460	.2450	.2439	.2428	.2415	.2400	.2383	.2360	.2322	
-16	.2525	.2516	.2506	.2495	.2484	.2471	.2457	.2442	.2423	.2399	.2360	
-15	.2572	.2562	.2552	.2541	.2529	.2515	.2501	.2484	.2465	.2439	.2397	
-14	.2621	.2610	.2599	.2587	.2574	.2561	.2545	.2528	.2507	.2480	.2436	
-13	.2670	.2659	.2647	.2635	.2621	.2606	.2590	.2572	.2550	.2521	.2474	
-12	.2721	.2709	.2696	.2683	.2669	.2653	.2636	.2617	.2593	.2563	.2514	
-11	.2772	.2760	.2746	.2732	.2717	.2701	.2683	.2662	.2638	.2606	.2553	
-10	.2825	.2811	.2800	.2789	.2767	.2749	.2730	.2708	.2683	.2649	.2593	
-9	.2878	.2864	.2850	.2834	.2817	.2799	.2779	.2756	.2728	.2693	.2634	
-8	.2933	.2918	.2903	.2886	.2869	.2849	.2828	.2804	.2775	.2737	.2675	
-7	.2989	.2974	.2957	.2940	.2921	.2901	.2878	.2852	.2822	.2783	.2717	
-6	.3046	.3030	.3013	.2994	.2974	.2953	.2929	.2902	.2870	.2828	.2760	
-5	.3105	.3087	.3069	.3050	.3029	.3006	.2981	.2953	.2919	.2875	.2802	
-4	.3164	.3146	.3127	.3107	.3085	.3061	.3034	.3004	.2969	.2922	.2846	
-3	.3225	.3206	.3186	.3164	.3141	.3116	.3088	.3057	.3019	.2970	.2890	
-2	.3288	.3268	.3246	.3224	.3199	.3173	.3143	.3110	.3070	.3019	.2934	
-1	.3351	.3330	.3308	.3284	.3258	.3230	.3199	.3164	.3123	.3069	.2979	
0	.3417	.3394	.3371	.3345	.3318	.3289	.3257	.3220	.3176	.3119	.3025	
1	.3483	.3460	.3435	.3408	.3380	.3349	.3315	.3276	.3230	.3170	.3071	
2	.3551	.3527	.3500	.3473	.3443	.3410	.3374	.3333	.3285	.3222	.3118	
3	.3621	.3595	.3567	.3538	.3507	.3473	.3435	.3392	.3341	.3275	.3165	
4	.3692	.3665	.3636	.3605	.3572	.3536	.3497	.3451	.3398	.3328	.3213	
5	.3765	.3736	.3706	.3674	.3639	.3601	.3559	.3512	.3456	.3383	.3262	
6	.3840	.3809	.3778	.3744	.3707	.3667	.3624	.3574	.3515	.3438	.3311	
7	.3916	.3884	.3851	.3815	.3777	.3735	.3689	.3637	.3575	.3494	.3363	
8	.3994	.3961	.3925	.3888	.3848	.3804	.3756	.3701	.3636	.3551	.3411	
9	.4074	.4039	.4002	.3963	.3920	.3874	.3824	.3766	.3698	.3609	.3462	
10	.4155	.4119	.4080	.4039	.3995	.3947	.3893	.3833	.3761	.3668	.3514	
11	.4239	.4200	.4160	.4117	.4070	.4020	.3964	.3901	.3826	.3728	.3566	
12	.4324	.4284	.4242	.4196	.4148	.4095	.4036	.3970	.3891	.3789	.3619	
13	.4412	.4370	.4325	.4278	.4227	.4171	.4110	.4041	.3958	.3851	.3673	
14	.4501	.4457	.4411	.4361	.4308	.4250	.4185	.4112	.4026	.3913	.3727	

Continued on next page

Table 6 continued

°C	Percent relative humidity											
	100	90	80	70	60	50	40	30	20	10	1	
15	0.4593	0.4547	0.4498	0.4446	0.4390	0.4329	0.4262	0.4186	0.4095	0.3977	0.3782	
16	.4687	.4639	.4588	.4533	.4475	.4411	.4340	.4261	.4166	.4042	.3838	
17	.4783	.4733	.4679	.4622	.4561	.4494	.4420	.4337	.4238	.4108	.3895	
18	.4882	.4829	.4773	.4713	.4649	.4579	.4502	.4414	.4311	.4175	.3952	
19	.4982	.4927	.4868	.4806	.4739	.4666	.4585	.4494	.4385	.4244	.4010	
20	.5086	.5028	.4966	.4901	.4831	.4755	.4670	.4575	.4461	.4313	.4069	
21	.5191	.5131	.5067	.4998	.4925	.4845	.4757	.4657	.4538	.4383	.4128	
22	.5300	.5236	.5169	.5098	.5021	.4938	.4846	.4741	.4617	.4455	.4188	
23	.5410	.5344	.5274	.5200	.5120	.5032	.4936	.4827	.4697	.4528	.4253	
24	.5524	.5455	.5382	.5304	.5220	.5129	.5028	.4914	.4779	.4602	.4311	
25	.5640	.5568	.5492	.5410	.5323	.5228	.5123	.5004	.4862	.4678	.4373	
26	.5759	.5684	.5604	.5519	.5428	.5329	.5219	.5095	.4947	.4754	.4437	
27	.5881	.5802	.5719	.5631	.5535	.5432	.5317	.5187	.5033	.4832	.4501	
28	.6006	.5924	.5837	.5745	.5645	.5537	.5418	.5282	.5121	.4912	.4566	
29	.6134	.6048	.5958	.5861	.5758	.5645	.5520	.5379	.5211	.4992	.4631	
30	.6265	.6176	.6081	.5981	.5873	.5755	.5625	.5478	.5303	.5075	.4698	
31	.6399	.6306	.6208	.6103	.5990	.5868	.5732	.5578	.5396	.5158	.4765	
32	.6537	.6440	.6337	.6228	.6110	.5983	.5841	.5681	.5491	.5243	.4834	
33	.6678	.6577	.6470	.6356	.6233	.6100	.5953	.5786	.5588	.5329	.4903	
34	.6822	.6717	.6605	.6487	.6359	.6221	.6067	.5893	.5686	.5417	.4973	
35	.6970	.6860	.6744	.6621	.6488	.6343	.6184	.6002	.5787	.5507	.5044	
36	.7122	.7007	.6887	.6758	.6619	.6469	.6303	.6114	.5890	.5598	.5116	
37	.7277	.7158	.7032	.6898	.6754	.6597	.6424	.6228	.5994	.5690	.5189	
38	.7436	.7312	.7181	.7042	.6892	.6729	.6548	.6344	.6101	.5785	.5262	
39	.7599	.7470	.7334	.7188	.7033	.6863	.6675	.6462	.6210	.5881	.5337	
40	.7766	.7632	.7490	.7339	.7176	.7000	.6805	.6583	.6321	.5978	.5413	
41	.7937	.7797	.7650	.7493	.7324	.7140	.6937	.6707	.6434	.6077	.5489	
42	.8112	.7967	.7814	.7650	.7475	.7284	.7073	.6833	.6549	.6179	.5567	
43	.8292	.8141	.7981	.7811	.7629	.7430	.7211	.6962	.6666	.6281	.5646	
44	.8475	.8319	.8153	.7976	.7787	.7568	.7352	.7093	.6786	.6386	.5725	
45	.8664	.8501	.8328	.8145	.7948	.7734	.7497	.7228	.6908	.6493	.5806	
46	.8857	.8687	.8508	.8318	.8113	.7890	.7644	.7365	.7033	.6601	.5888	
47	.9054	.8878	.8693	.8495	.8282	.8051	.7795	.7505	.7160	.6711	.5971	
48	.9257	.9074	.8881	.8676	.8455	.8215	.7949	.7647	.7290	.6824	.6054	
49	.9464	.9274	.9074	.8861	.8631	.8382	.8106	.7793	.7422	.6938	.6139	
50	.9677	.9480	.9272	.9050	.8812	.8553	.8267	.7942	.7557	.7054	.6225	

In table 7 the long-wave clear-sky radiation has been derived solely from screen-height air temperature as calculated by the Idso-Jackson formula (Idso and Jackson 1969):

$$I_{\downarrow} = \sigma T^4 \{1.0 - 0.261 \exp [-7.77 \times 10^{-4} (273 - T)^2]\}$$

where $I_{\downarrow}$ is the clear-sky radiation in $\text{cal cm}^{-2} \text{ min}^{-1}$, σ is the Stefan-Boltzmann constant, and T is the screen-height air temperature in $^{\circ}\text{K}$. The values presented in table 7 have been supplied by S. B. Idso¹ and were calculated with a σ value of $8.17 \times 10^{-11} \text{ cal cm}^{-2} \text{ min}^{-1} \text{ }^{\circ}\text{K}^{-4}$.

¹Personal communication with S. B. Idso.

Table 7.--Idso-Jackson formula, $I^+ = \sigma T^4 \{1.0 - 0.261 \exp [-7.77 \times 10^{-4} (273 - T)^2]\}$, for atmospheric radiation

(In $\text{cal cm}^{-2} \text{min}^{-1}$)

°C	°K	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
-40	233	.0222	.0222	.0222	.0222	.0221	.0221	.0221	.0220	.0220	.0220
-39	234	.225	.225	.225	.224	.224	.224	.223	.223	.223	.223
-38	235	.228	.227	.227	.227	.227	.226	.226	.226	.226	.225
-37	236	.230	.230	.230	.230	.229	.229	.229	.229	.228	.228
-36	237	.233	.233	.232	.232	.232	.232	.231	.231	.231	.231
-35	238	.235	.235	.235	.235	.234	.234	.234	.234	.233	.233
-34	239	.238	.238	.237	.237	.237	.237	.236	.236	.236	.236
-33	240	.240	.240	.240	.240	.239	.239	.239	.239	.238	.238
-32	241	.243	.243	.242	.242	.242	.242	.241	.241	.241	.241
-31	242	.245	.245	.245	.245	.244	.244	.244	.244	.243	.243
-30	243	.248	.247	.247	.247	.247	.247	.246	.246	.246	.246
-29	244	.250	.250	.250	.249	.249	.249	.249	.248	.248	.248
-28	245	.252	.252	.252	.252	.252	.251	.251	.251	.251	.250
-27	246	.255	.254	.254	.254	.254	.254	.253	.253	.253	.253
-26	247	.257	.257	.256	.256	.256	.256	.256	.255	.255	.255
-25	248	.259	.259	.259	.259	.258	.258	.258	.258	.257	.257
-24	249	.261	.261	.261	.261	.261	.260	.260	.260	.260	.259
-23	250	.264	.263	.263	.263	.263	.263	.262	.262	.262	.262
-22	251	.266	.266	.265	.265	.265	.265	.265	.264	.264	.264
-21	252	.268	.268	.268	.268	.267	.267	.267	.267	.266	.266
-20	253	.270	.270	.270	.270	.270	.269	.269	.269	.269	.268
-19	254	.273	.273	.272	.272	.272	.272	.271	.271	.271	.271
-18	255	.275	.275	.275	.274	.274	.274	.274	.273	.273	.273
-17	256	.277	.277	.277	.277	.277	.276	.276	.276	.276	.275
-16	257	.280	.280	.279	.279	.279	.279	.278	.278	.278	.278
-15	258	.282	.282	.282	.282	.281	.281	.281	.281	.280	.280
-14	259	.285	.285	.284	.284	.284	.284	.283	.283	.283	.283
-13	260	.288	.287	.287	.287	.287	.286	.286	.286	.286	.285
-12	261	.290	.290	.290	.290	.289	.289	.289	.288	.288	.288
-11	262	.293	.293	.293	.292	.292	.292	.291	.291	.291	.291
-10	263	.296	.296	.296	.295	.295	.295	.294	.294	.294	.294
-9	264	.299	.299	.299	.298	.298	.298	.297	.297	.297	.296
-8	265	.303	.302	.302	.302	.301	.301	.301	.300	.300	.300
-7	266	.306	.306	.305	.305	.305	.304	.304	.304	.303	.303
-6	267	.309	.309	.309	.308	.308	.308	.307	.307	.307	.306
-5	268	.313	.313	.312	.312	.312	.311	.311	.311	.310	.310
-4	269	.317	.317	.316	.316	.316	.315	.315	.314	.314	.314
-3	270	.321	.321	.320	.320	.320	.319	.319	.318	.318	.318
-2	271	.326	.325	.325	.324	.324	.323	.323	.323	.322	.322
-1	272	.330	.330	.329	.329	.328	.328	.327	.327	.326	.326
-0	273	.335	.334	.334	.333	.333	.332	.332	.332	.331	.331
+0	273	.335	.336	.336	.337	.337	.338	.338	.339	.339	.340
1	274	.340	.341	.341	.342	.342	.343	.344	.344	.345	.345
2	275	.346	.346	.347	.347	.348	.349	.349	.350	.350	.351
3	276	.351	.352	.352	.353	.353	.354	.355	.355	.356	.356
4	277	.357	.358	.358	.359	.359	.360	.361	.361	.362	.362
5	278	.363	.364	.364	.365	.366	.366	.367	.367	.368	.369
6	279	.369	.370	.371	.371	.372	.373	.373	.374	.375	.375
7	280	.376	.377	.377	.378	.379	.379	.380	.381	.381	.382
8	281	.383	.384	.384	.385	.386	.386	.387	.388	.389	.389
9	282	.390	.391	.392	.392	.393	.394	.394	.395	.396	.397
10	283	.397	.398	.399	.400	.401	.401	.402	.403	.404	.404
11	284	.405	.406	.407	.408	.408	.409	.410	.411	.412	.412
12	285	.413	.414	.415	.416	.417	.417	.418	.419	.420	.421
13	286	.422	.422	.423	.424	.425	.426	.427	.427	.428	.429
14	287	.430	.431	.432	.433	.434	.434	.435	.436	.437	.438

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Table 7 continued

°C	°K	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
15	288	.439	.440	.441	.442	.443	.443	.444	.445	.446	.447
16	289	.448	.449	.450	.451	.452	.453	.454	.455	.455	.456
17	290	.457	.458	.459	.460	.461	.462	.463	.464	.465	.466
18	291	.467	.468	.469	.470	.471	.472	.473	.474	.475	.476
19	292	.477	.478	.479	.480	.481	.482	.483	.484	.485	.486
20	293	.487	.488	.489	.490	.491	.492	.493	.494	.495	.496
21	294	.497	.498	.499	.500	.502	.503	.504	.505	.506	.507
22	295	.508	.509	.510	.511	.512	.513	.514	.515	.516	.518
23	296	.519	.520	.521	.522	.523	.524	.525	.526	.527	.529
24	297	.530	.531	.532	.533	.534	.535	.536	.537	.539	.540
25	298	.541	.542	.543	.544	.545	.546	.548	.549	.550	.551
26	299	.552	.553	.554	.556	.557	.558	.559	.560	.561	.563
27	300	.564	.565	.566	.567	.568	.570	.571	.572	.573	.574
28	301	.575	.577	.578	.579	.580	.581	.583	.584	.585	.586
29	302	.587	.589	.590	.591	.592	.593	.595	.596	.597	.598
30	303	.599	.601	.602	.603	.604	.605	.607	.608	.609	.610
31	304	.611	.613	.614	.615	.616	.618	.619	.620	.621	.622
32	305	.624	.625	.626	.627	.629	.630	.631	.632	.634	.635
33	306	.636	.637	.639	.640	.641	.642	.644	.645	.646	.647
34	307	.649	.650	.651	.652	.654	.655	.656	.657	.659	.660
35	308	.661	.662	.664	.665	.666	.667	.669	.670	.671	.673
36	309	.674	.675	.676	.678	.679	.680	.681	.683	.684	.685
37	310	.687	.688	.689	.690	.692	.693	.694	.695	.697	.698
38	311	.699	.701	.702	.703	.704	.706	.707	.708	.710	.711
39	312	.712	.713	.715	.716	.717	.719	.720	.721	.723	.724
40	313	.725	.726	.728	.729	.730	.732	.733	.734	.735	.737
41	314	.738	.739	.741	.742	.743	.745	.746	.747	.748	.750
42	315	.751	.752	.754	.755	.756	.758	.759	.760	.761	.763
43	316	.764	.765	.767	.768	.769	.771	.772	.773	.775	.776
44	317	.777	.778	.780	.781	.782	.784	.785	.786	.788	.789
45	318	.790	.792	.793	.794	.796	.797	.798	.799	.801	.802
46	319	.803	.805	.806	.807	.809	.810	.811	.813	.814	.815
47	320	.817	.818	.819	.820	.822	.823	.824	.826	.827	.828
48	321	.830	.831	.832	.834	.835	.836	.838	.839	.840	.842
49	322	.843	.844	.845	.847	.848	.849	.851	.852	.853	.855

SOLAR RADIATION

Time Correction

The Earth is divided into 24 standard time zones, each 15° wide and extending 7½° on either side of a standard meridian. Because the Sun takes 1 hour to cross a time zone, it crosses 1° of longitude in 4 minutes. Therefore, in order to obtain "true local time" (mean solar time) it is necessary to add 4 minutes for each degree of longitude east of the standard meridian, or subtract 4 minutes for each degree of longitude west of the standard meridian.

The first standard meridian (0° longitude) passes through Greenwich, with successive meridians being multiples of 15° of longitude west of the 0° meridian of Greenwich. It should be noted that over land masses the standard time zones seldom extend exactly 7°30' from either side of the standard meridian, but rather follow geographical or political boundaries.

To obtain true (apparent) solar time it is necessary to algebraically add a correction for the "equation of time" to the true local time. These corrections are listed in table 8, in minutes (M) and seconds (S).

Position

The overhead position of the Sun is shown in figures 1 through 6 (redrawn from List, 1968) for various latitudes. The altitude and azimuth can be determined for any time or date from these diagrams. The altitude or elevation of the Sun above the horizon, in degrees, is determined from the concentric circles, and the azimuth from the radial lines. The outer circle (0° elevation) obviously represents true sunrise or sunset, rather than apparent sunrise or sunset which is due to atmospheric refraction. Under average conditions, in the latitudes covered by these diagrams, apparent sunrise or sunset will occur when the Sun is less than 1 degree below the horizon.

All diagram times are true (apparent) solar times and must be corrected for longitude and the "equation of time" for local standard time. Thus, by selecting the appropriate diagram and Sun path line, the position of the Sun, shading, slope exposure, etc. can be determined for any time of day. Interpolation is permissible.

Table 8.--Corrections in minutes (M) and seconds (S) to obtain true solar time from equation of time

Month	Day															
	1		5		9		13		17		21		25		29	
	M	S	M	S	M	S	M	S	M	S	M	S	M	S	M	S
Jan.	-3	14	-5	6	-6	50	-8	27	-9	54	-11	10	-12	14	-13	5
Feb.	-13	34	-14	2	-14	17	-14	20	-14	10	-13	50	-13	19	--	--
March	-12	38	-11	48	-10	51	-9	49	-8	42	-7	32	-6	20	-5	7
April	-4	12	-3	1	-1	52	-0	47	+0	13	+1	6	+1	53	+2	33
May	+2	50	+3	17	+3	35	+3	44	+3	44	+3	34	+3	16	+2	51
June	+2	27	+1	49	+1	6	+0	18	-0	33	-1	25	-2	17	-3	7
July	-3	31	-4	16	-4	56	-5	30	-5	57	-6	15	-6	24	-6	23
Aug.	-6	17	-5	59	-5	33	-4	57	-4	12	-3	19	-2	18	-1	10
Sept.	-0	15	+1	2	+2	22	+3	45	+5	10	+6	35	+8	0	+9	22
Oct.	+10	1	+11	17	+12	27	+13	30	+14	25	+15	10	+15	46	+16	10
Nov.	+16	21	+16	23	+16	12	+15	47	+15	10	+14	18	+13	15	+11	59
Dec.	+11	16	+9	43	+8	1	+6	12	+4	17	+2	19	+0	20	-1	39

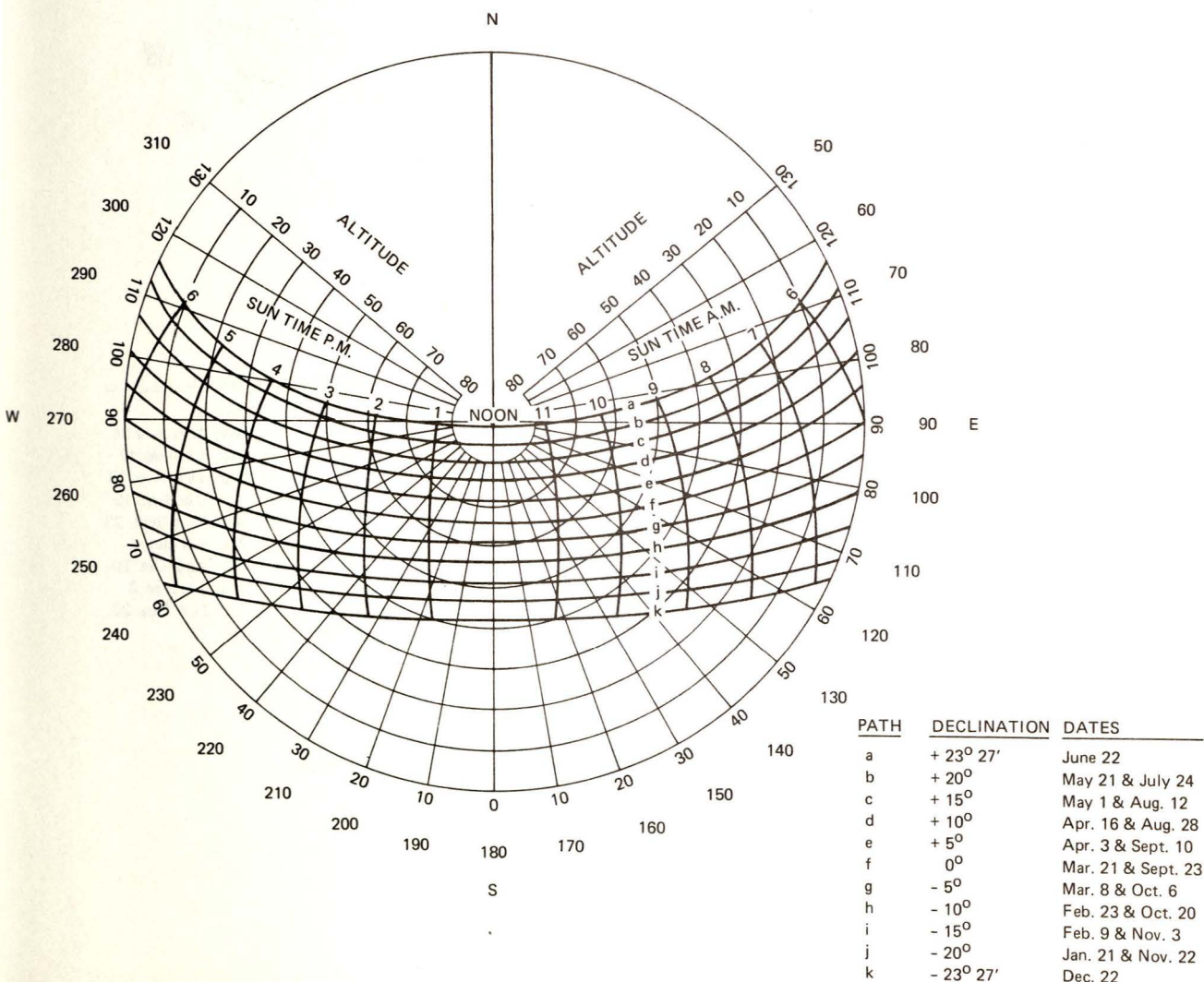
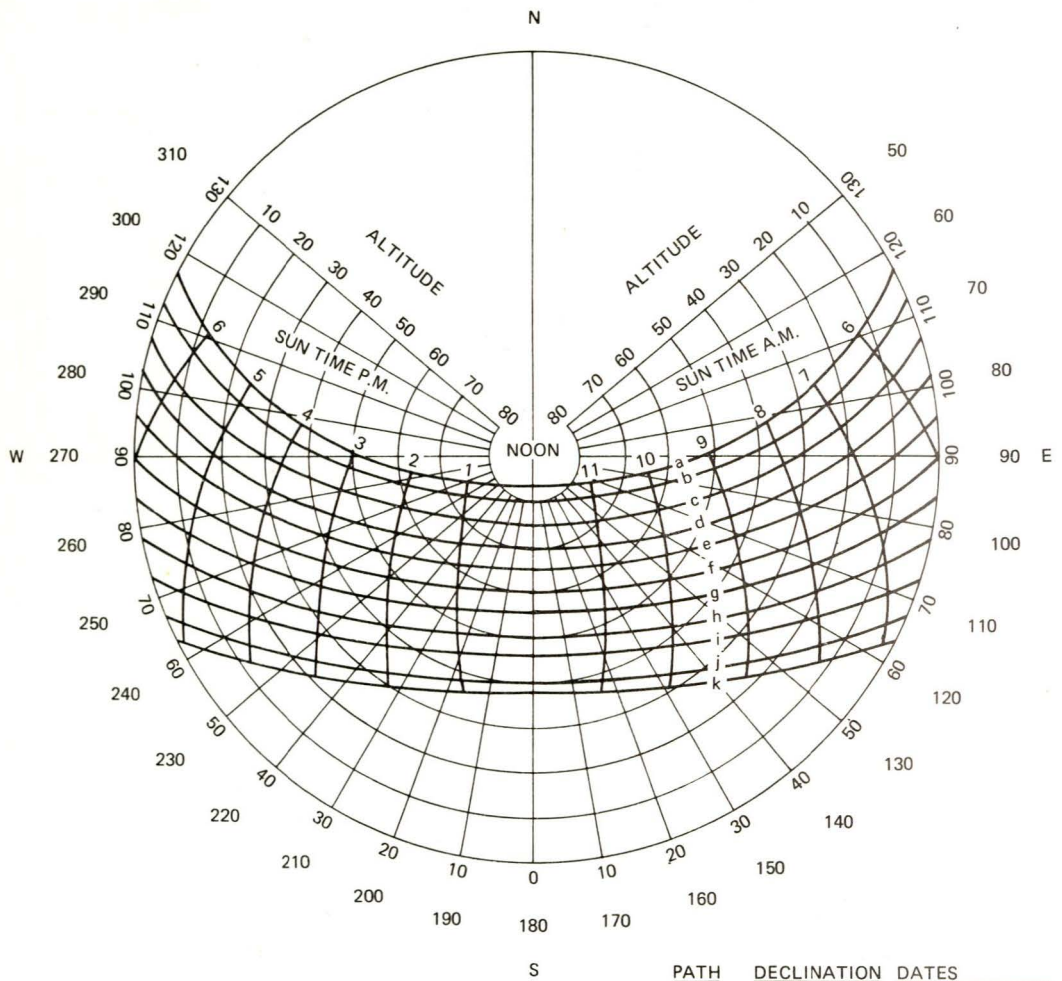
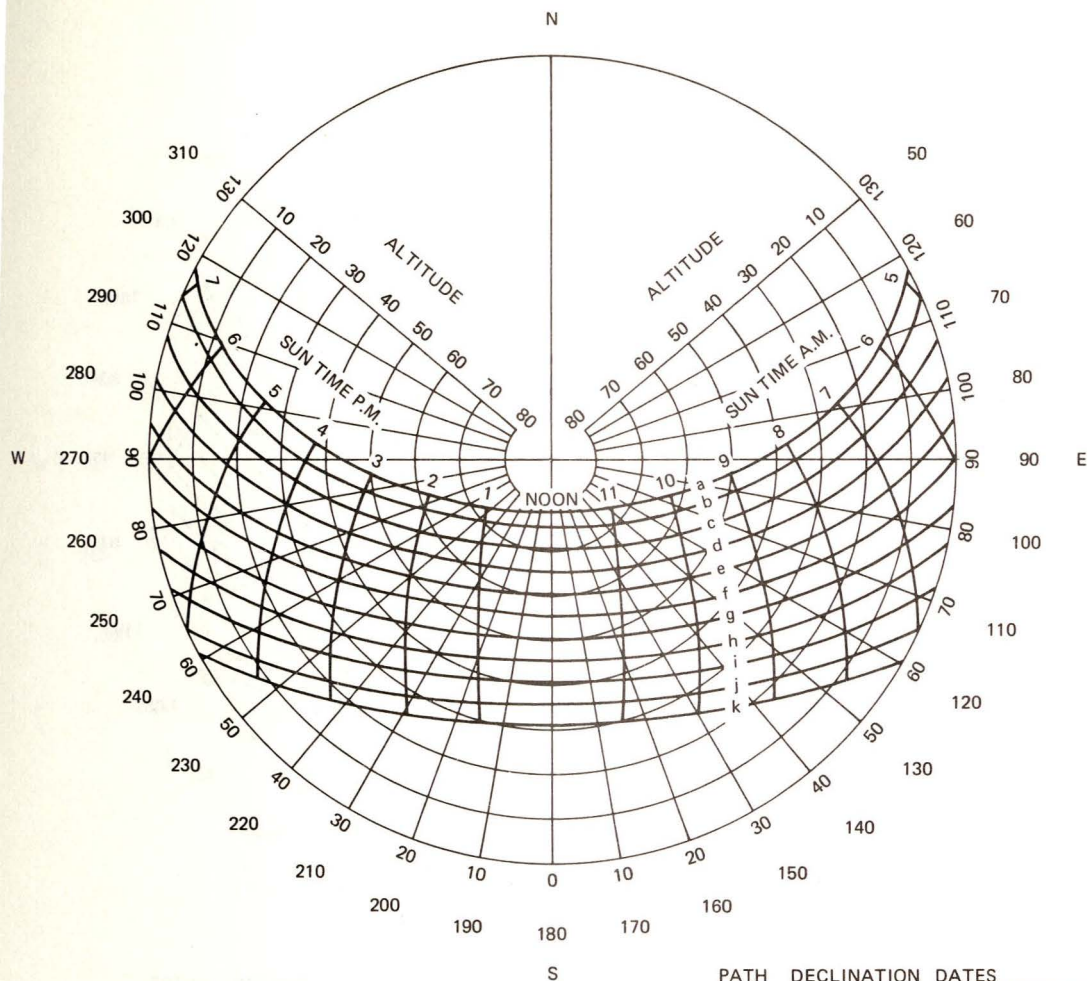


Figure 1.--Sun path diagram for 25° N. latitude.



<u>PATH</u>	<u>DECLINATION</u>	<u>DATES</u>
a	+ 23° 27'	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	- 10°	Feb. 23 & Oct. 20
i	- 15°	Feb. 9 & Nov. 3
j	- 20°	Jan. 21 & Nov. 22
k	- 23° 27'	Dec. 22

Figure 2.--Sun path diagram for 30° N. latitude.



PATH	DECLINATION	DATES
a	+ 23° 27'	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	- 10°	Feb. 23 & Oct. 20
i	- 15°	Feb. 9 & Nov. 3
j	- 20°	Jan. 21 & Nov. 22
k	- 23° 27'	Dec. 22

Figure 3.--Sun path diagram for 35° N. latitude.

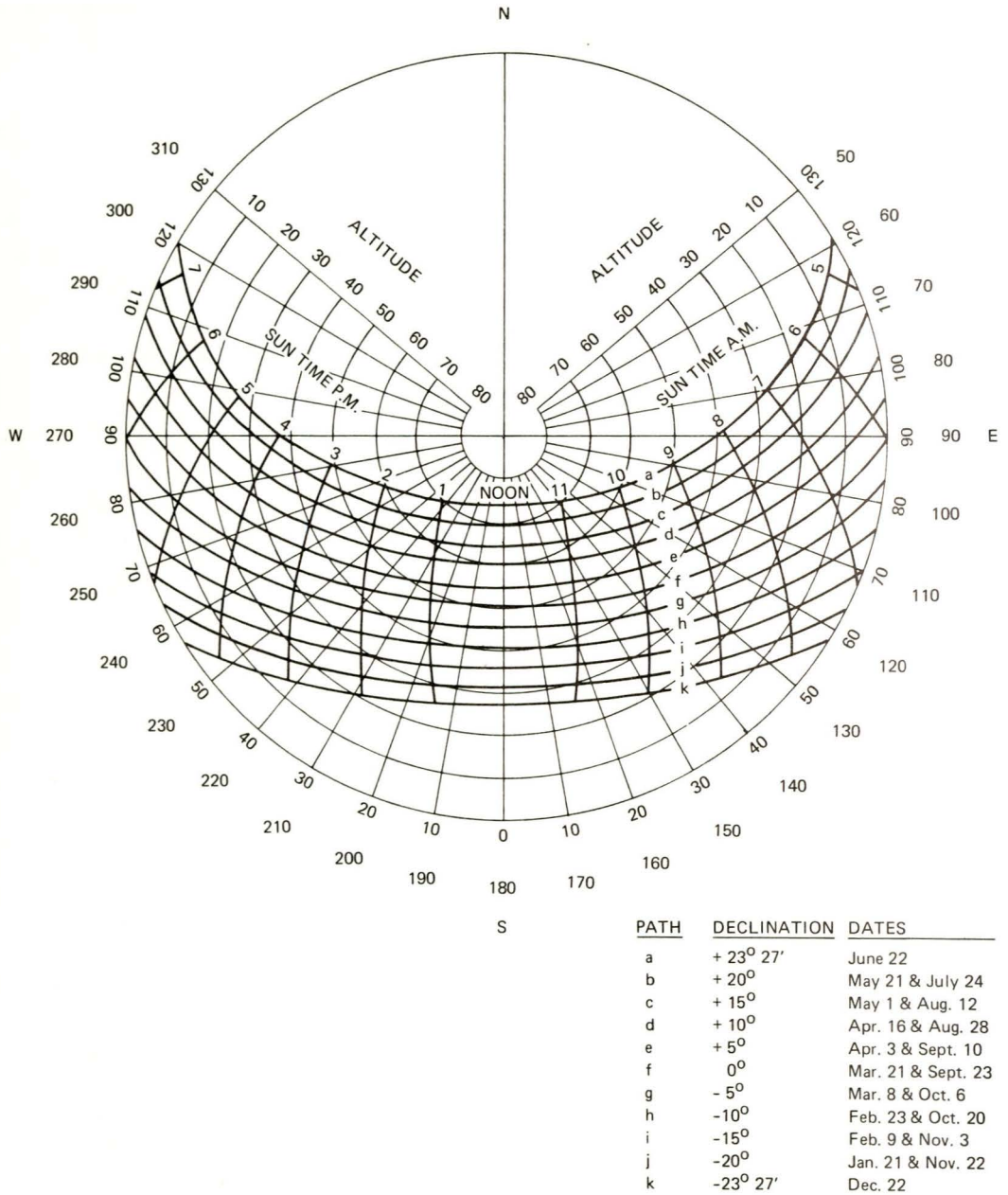
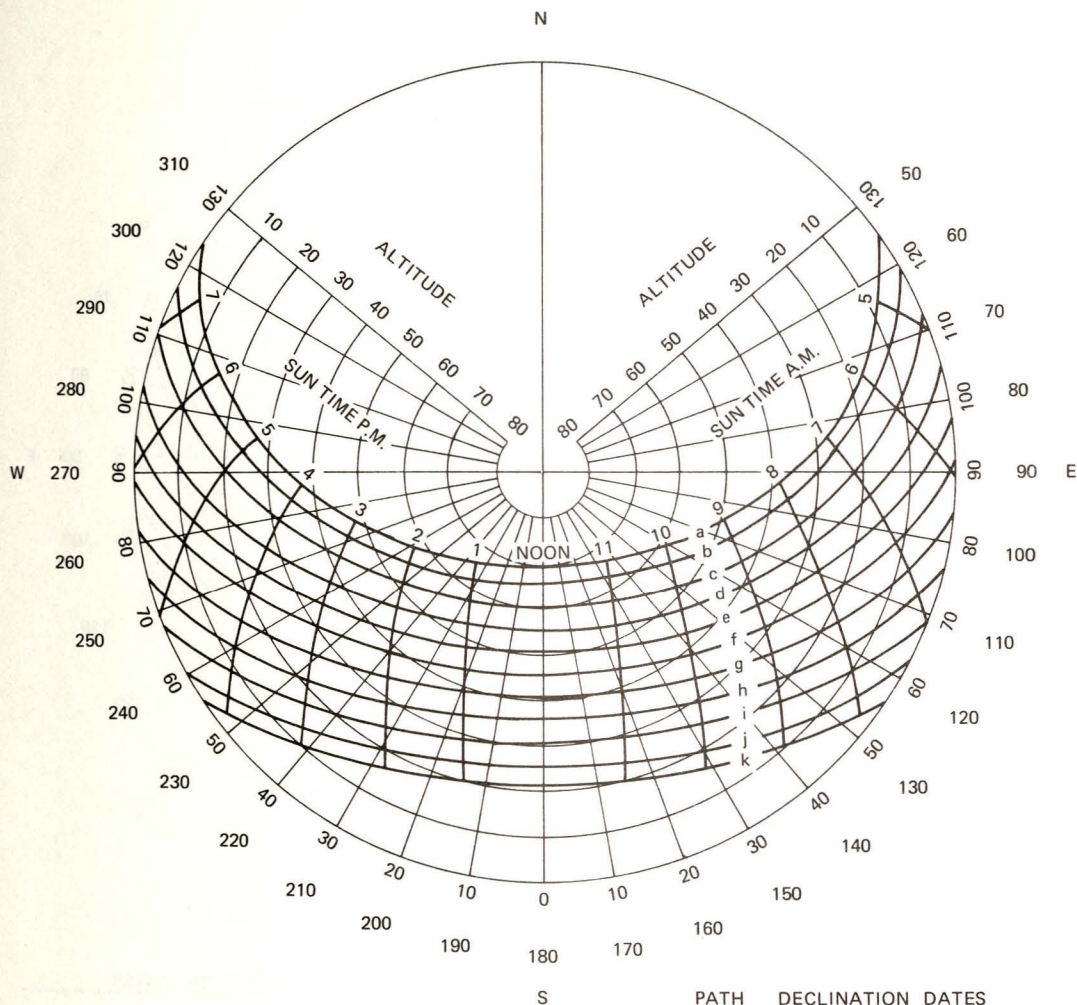


Figure 4.--Sun path diagram for 40° N. latitude.



<u>PATH</u>	<u>DECLINATION</u>	<u>DATES</u>
a	+ 23° 27'	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	- 10°	Feb. 23 & Oct. 20
i	- 15°	Feb. 9 & Nov. 3
j	- 20°	Jan. 21 & Nov. 22
k	- 23° 27'	Dec. 22

Figure 5.--Sun path diagram for 45° N. latitude.

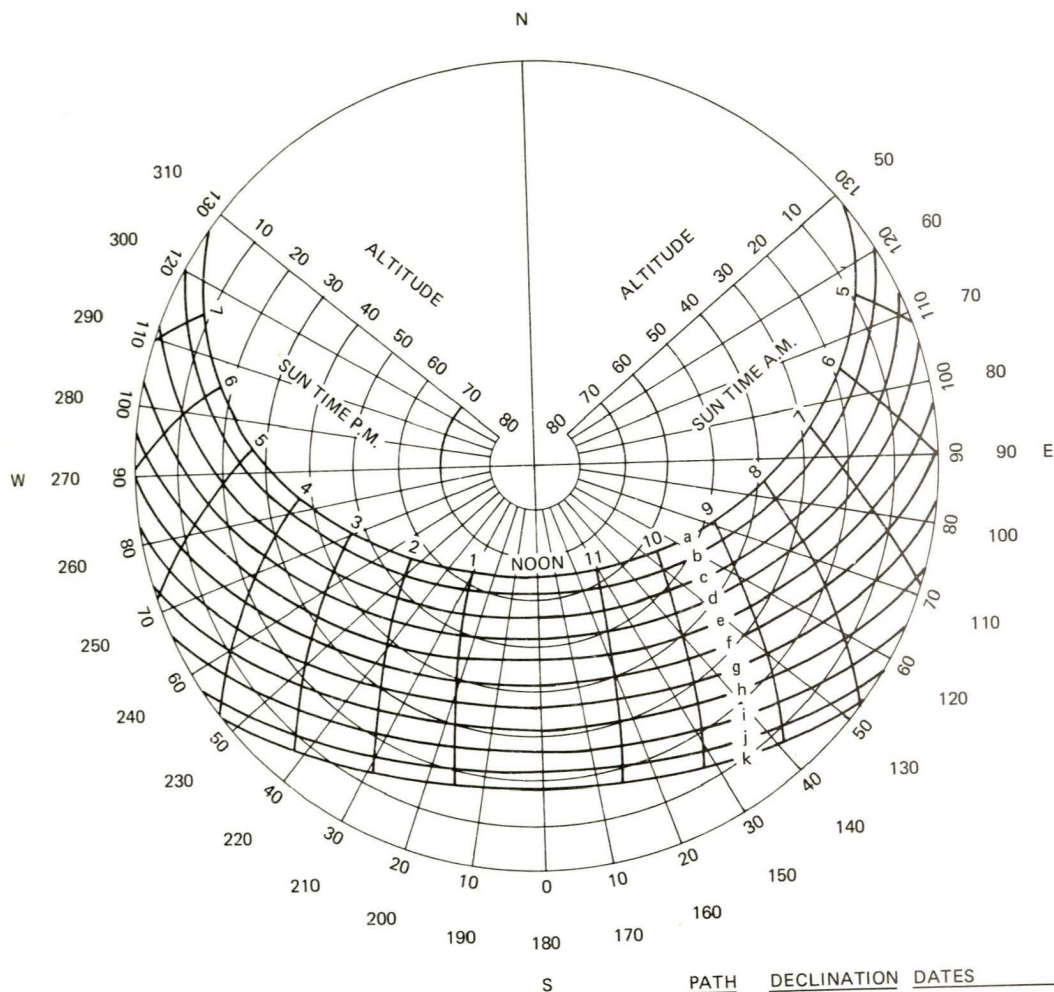


Figure 6.--Sun path diagram for 50° N. latitude.

PATH	DECLINATION	DATES
a	+ 23° 27'	June 22
b	+ 20°	May 21 & July 24
c	+ 15°	May 1 & Aug. 12
d	+ 10°	Apr. 16 & Aug. 28
e	+ 5°	Apr. 3 & Sept. 10
f	0°	Mar. 21 & Sept. 23
g	- 5°	Mar. 8 & Oct. 6
h	- 10°	Feb. 23 & Oct. 20
i	- 15°	Feb. 9 & Nov. 3
j	- 20°	Jan. 21 & Nov. 22
k	- 23° 27'	Dec. 22

Potential Solar Radiation

The potential or amount of solar irradiation at the top of the atmosphere is shown in figure 7 for various latitudes in langley's day⁻¹ (cal cm⁻² day⁻¹). These data are from Frank and Lee (1966) and represent the potential radiation on a horizontal surface. By introducing factors to account for cloudiness and atmospheric turbidity, estimates of actual irradiation on a horizontal surface may be obtained. For solar irradiation on slopes see Frank and Lee (1966), Fons *et al.* (1960), and Buffo *et al.* (1972).

Spectral Distribution

The spectral distribution of direct beam sunlight, skylight, cloudlight, and the light transmitted through vegetation is shown in figure 8 from Gates (1965). In this figure the intensity is plotted by wave number, allowing the full spectrum to be shown. The different spectral distribution of sunlight, cloudlight, skylight, and the light transmitted through vegetation may have profound ecological consequences. These factors must also be considered when using energy sensors of different spectral sensitivities.

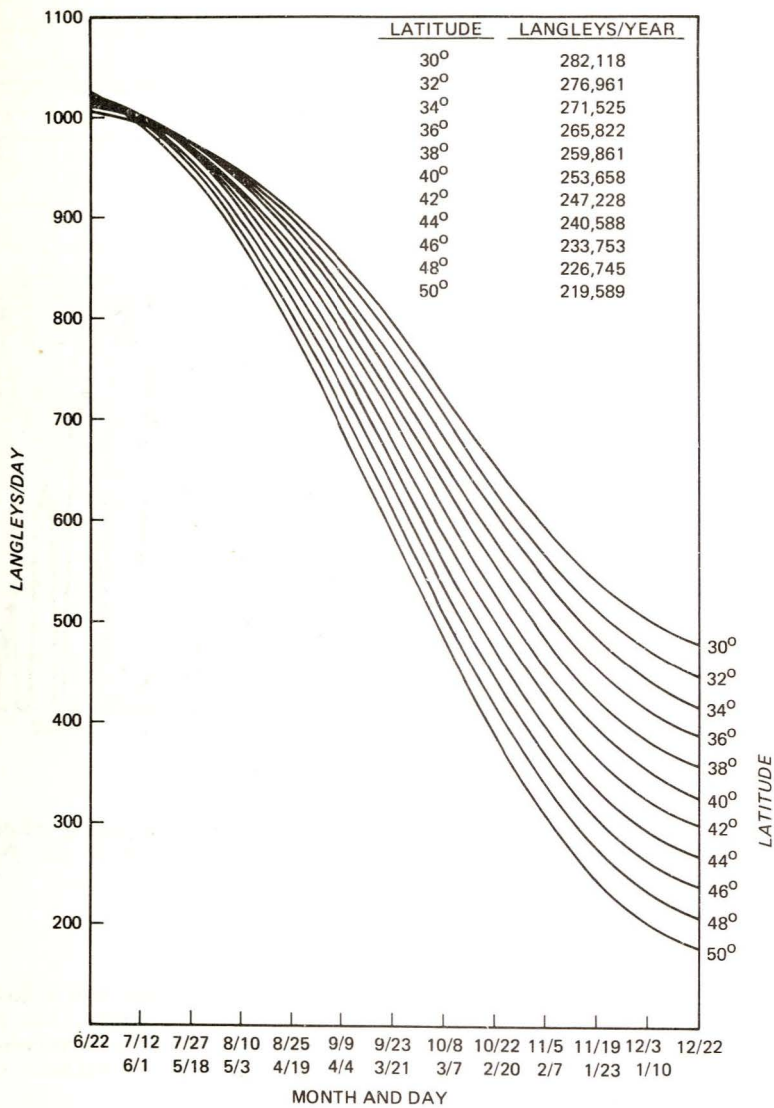


Figure 7.--Potential solar beam irradiation on a horizontal surface for various latitudes and dates.

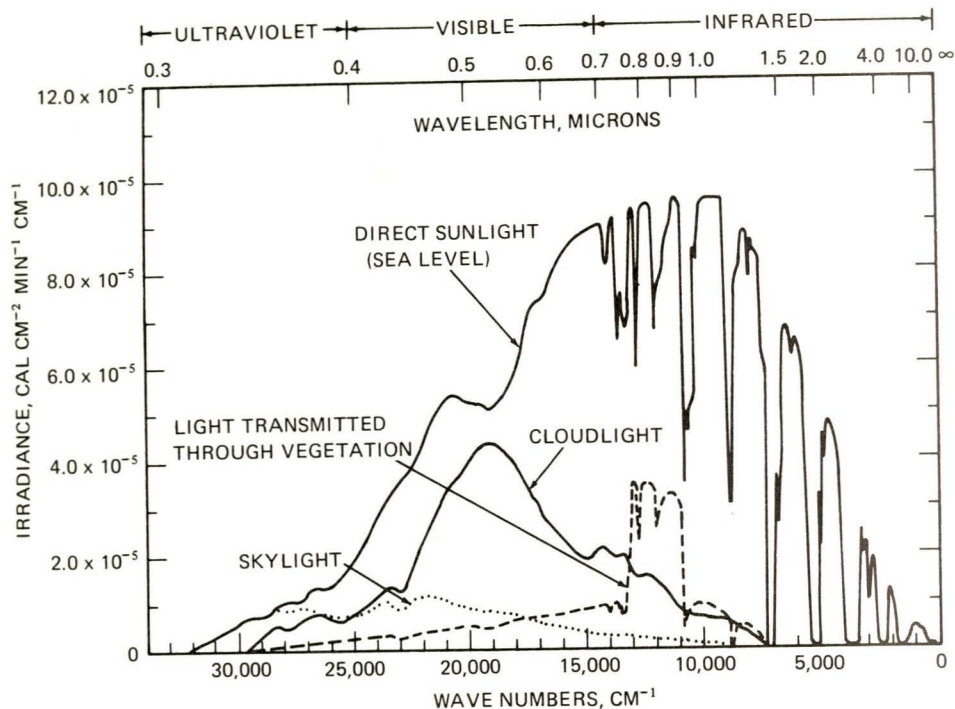


Figure 8.--Spectral distribution of direct sunlight, skylight, cloudlight, and light transmitted through vegetation as a function of the frequency of radiation in wave numbers (Gates 1965).

WATER

A psychrometric chart (fig. 9) enables the user to determine various factors of water vapor in the air, when two factors are known. Dry bulb temperature, wet bulb temperature, relative humidity, dew point (in °C and °F), vapor pressure (in inches of mercury, millimeters of mercury, and millibars), and absolute humidity (in grams/cubic feet, grams/kilogram of air, and grams/cubic meter) are included on the chart.

Although prepared for a barometric pressure of 30 inches of mercury, the chart may be used in most cases down to a barometric pressure of 28 inches of mercury without correction.

Inches of water per pound of rain or snow can be determined for rain gauges of various diameters (fig. 10).

Volumes and weights of water per surface area by depth of precipitation are in table 9.



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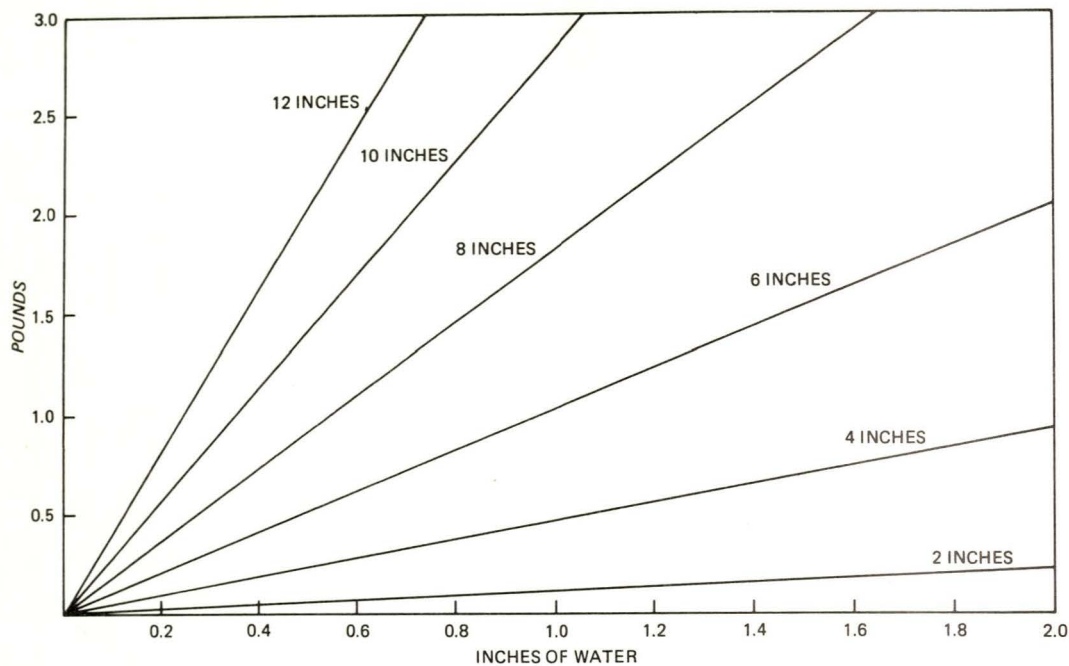


Figure 10.--Inches of water from pounds of rain or snow collected in gauges of various diameters.

Table 9.--Amounts of water by depth of precipitation

Precipitation (inches)	Gal/acre	Tons/acre	1,000 gal/mile ²	Tons/mile ²	Acre ft/mile ²
0.01	272	1	1.7	723	0.5
.02	543	2	35	1,446	1.1
.03	815	3	52	2,170	1.6
.04	1,086	5	70	2,893	2.1
.05	1,358	6	87	3,616	2.7
.06	1,629	7	104	4,339	3.2
.07	1,901	8	122	5,062	3.7
.08	2,172	9	139	5,786	4.3
.09	2,444	10	156	6,509	4.8
.10	2,715	11	174	7,232	5.3
.20	5,431	23	348	14,464	10.7
.30	8,146	34	521	21,696	16.0
.40	10,862	45	695	28,928	21.3
.50	13,577	57	869	36,160	26.7
.60	16,292	68	1,043	43,392	32.0
.70	19,008	79	1,216	50,624	37.3
.80	21,723	91	1,390	57,856	42.7
.90	24,439	102	1,564	65,088	48.0
1.00	27,154	113	1,738	72,320	53.3
2.00	54,308	227	3,476	144,640	106.7
3.00	81,462	340	5,214	216,960	160.0
4.00	108,616	453	6,951	289,280	213.3
5.00	135,770	566	8,689	361,600	266.7
6.00	162,924	680	10,427	433,920	320.0
7.00	190,078	793	12,165	506,240	373.3
8.00	217,232	906	13,903	578,560	426.7
9.00	244,386	1,019	15,641	650,880	480.0

CONVERSION FACTORS

Angle

To Convert	Into	Multiply by	To Convert	Into	Multiply by
degrees	min	60.0	sq ft (contd)	sq miles	3.587×10^{-8}
	quadrants	0.01111		sq mm	9.290×10^4
	radians	0.01745		sq rods	3.67309×10^{-3}
	sec	3,600.0		sq yd	0.1111
min	degrees	0.01667	sq in.	sq chains	1.59423×10^{-6}
	quadrants	1.852×10^{-4}		sq cm	6.451626
	radians	2.909×10^{-4}		sq ft	6.9444×10^{-3}
	sec	60.0		sq links	0.0159423
quadrants	degrees	90.0	sq m	sq m	6.451626×10^{-4}
	min	5400.0		sq mm	645.1626
	radians	1.571		sq yd	7.716×10^{-4}
	sec	3.240×10^5			
radians	degrees	57.2958	sq km	acres	247.1004
	min	3437.75		ares	1×10^4
	quadrants	0.6366		sq cm	1×10^{10}
	sec	2.0626×10^5		sq ft	10.764×10^6
sec	degrees	2.778×10^{-4}	sq links	sq in.	1.550×10^9
	min	0.01667		sq m	1×10^6
	quadrants	3.087×10^{-6}		sq miles	0.3861
	radians	4.8481×10^{-6}		sq yd	1.196×10^6

Area

acres	ares	40.46873	sq m	acres	2.471×10^{-4}
	sq chains	10.0		ares	0.01
	sq ft	43,560.0		sq chains	2.471×10^{-3}
	ha	0.4047		sq cm	1×10^4
	sq link	1×10^5		ha	1×10^{-4}
	sq m	4,046.873		sq ft	10.7639
	sq mile	1.5625×10^{-3}		sq in.	1,550.0
	sq rods	160.0		sq km	1×10^{-6}
ha	sq yd	4,840.0	sq miles	sq links	24.7104
	acres	2.471044		sq miles	3.861×10^{-7}
	ares	100.0		sq mm	1×10^6
	sq ft	1.076×10^5		sq rods	0.039537
	sq m	1×10^4		sq yd	1.195985
	sq yd	1.19599×10^4			
	sq chains	2.4710×10^{-7}			
	sq ft	1.076×10^{-3}			
sq cm	sq in.	0.1550	sq rods	acres	640.0
	sq links	2.4710×10^{-3}		sq chains	6400.0
	sq m	0.0001		sq ft	2.78784×10^7
	sq miles	3.861×10^{-11}		ha	258.9998
	sq mm	100.0		sq km	2.589998
	sq rods	3.9537×10^{-6}		sq m	2.5899×10^6
	sq yd	1.196×10^{-4}		sq rods	1.0240×10^5
				sq yd	3.0976×10^6
sq ft	acres	2.29568×10^{-5}	sq mm	sq cm	0.01
	ares	9.29034×10^{-4}		sq in.	1.550×10^{-3}
	sq chains	2.29568×10^{-4}		sq ft	1.076×10^{-5}
	sq cm	929.0341		sq m	1×10^{-6}
	sq in.	144			
	sq links	2.29568			
	sq m	0.09290341			
			sq rods	acres	6.25×10^{-3}
				sq chains	0.0625
				sq ft	272.25

Area (contd)

To Convert	Into	Multiply by
sq rods (contd)	ha	2.5293×10^{-3}
	sq in.	3.9204×10^4
	sq links	625.0
	sq m	25.293
	sq miles	9.7656×10^{-6}
	sq yd	30.250
sq yd	acres	2.06612×10^{-4}
	ares	8.3613×10^{-3}
	sq chains	2.06612×10^{-3}
	sq cm	8,361.0
	sq ft	9.0
	ha	8.3613×10^{-5}
	sq in.	1,296.0
	sq links	20.6612
	sq m	0.83613
	sq miles	3.2283×10^{-7}
	sq rods	0.033058
townships	sq km	93.240
	sq miles	36.0

Density

g/cu cm	lb/cu in.	0.03613
	lb/cu ft	62.43
	lb/gal	8.3452
g/l	lb/1,000 gal	8.345
	lb/cu ft	0.062427
	ppm	1,000.0
kg/cu m	g/cu cm	0.001
	lb/cu ft	0.06243
	lb/cu in.	3.613×10^{-5}
mg/l	ppm	1.0
ppm	lb/million gal	8.345
lb/cu ft	g/cu cm	0.01602
	kg/cu m	16.018
	lb/cu in.	5.787×10^{-4}

lb/cu in.	g/cu cm	27.680
	kg/cu m	2.768×10^4
	lb/cu ft	1,728.0
lb/gal	g/cu cm	0.119826

Flow

acre-ft/day	cu ft/day	43,560.0
	cu ft/sec	0.504
	gal/day	3.26×10^5
	gal/min	226.0
	cu m/sec	0.0143
cu ft/day	acre-ft/day	2.30×10^{-5}
	cu ft/sec	1.16×10^{-5}
	gal/day	7.48
	gal/min	5.19×10^{-3}

Flow (contd)

To Convert	Into	Multiply by
cu ft/day (contd)	cu m/sec	3.28×10^{-7}
cu ft/sec	acre-ft/day	1.98
	cu ft/day	86,400
	gal/day	6.46×10^5
	gal/min	448.83
	million gal/day	0.646317
	l/min	1,699.3
gal/day	cu m/sec	0.0283
	cu yd/min	2.222
	acre-ft/day	3.07×10^{-6}
	cu ft/day	0.134
	cu ft/sec	1.55×10^{-6}
gal/min	gal/min	6.94×10^{-4}
	cu m/sec	4.38×10^{-8}
	acre-ft/day	4.42×10^{-3}
	cu ft/day	193.0
	cu ft/hr	8.0208
gal/sec	cu ft/sec	2.228×10^{-3}
	gal/day	1,440.0
	l/sec	0.06308
	cu m/sec	6.308×10^{-5}
	cu ft/min	8.0192

gal/min	acre-ft/day	4.42×10^{-3}
	cu ft/day	193.0
	cu ft/hr	8.0208
1/min	cu ft/sec	2.228×10^{-3}
	gal/day	1,440.0
	l/sec	0.06308
1/sec	cu m/sec	6.308×10^{-5}
	cu ft/min	8.0192
cu m/sec	acre-ft/day	70.0
	cu ft/day	3.05×10^6
	cu ft/sec	35.3
million gal/day	gal/day	2.28×10^7
	gal/min	15,800

million gal/day	cu ft/sec	1.54723
lb H ₂ O/min	cu ft/sec	2.670×10^{-4}
tons H ₂ O/day	cu ft/hr	1.3349
	gal/min	0.16643
	lb H ₂ O/hr	83.333

Force

dynes	g	1.0197×10^{-3}
	joules/cm	1×10^{-7}
	kg	1.0197×10^{-6}
	newtons	1×10^{-5}
g	dynes	980.665
	joules/cm	9.8066×10^{-5}
	newtons	9.086×10^{-3}
poundals	dynes	13,825.5
	g	14.098

Force (contd)

To Convert	Into	Multiply by
poundals (contd)	joules/cm newtons lb	1.383×10^{-3} 1.383 0.031081
lb	dynes joules/cm newtons poundals	4.4482×10^5 0.044482 4.4482 32.174
newtons	dynes joules/m	1×10^5 1.0
<u>Illumination</u>		
ft-candles	lumens/sq ft lumens/sq m lux milliphot	1.0 10.764 10.764 1.0764
lumens/sq ft	ft-candles lumens/sq m	1.0 10.764
lumens/sq m	ft-candles lux milliphot phot	0.0929 1.0 0.1 1×10^{-4}
lux	ft-candles lumens/sq m milliphot phot	0.0929 1.0 0.1 1×10^{-4}
phot	ft-candles lumens/sq m lumens/sq cm lux	929.0 1×10^4 1.0 1×10^4

Length

Angstrom unit	in. cm m microns	3.937×10^{-9} 1×10^{-8} 1×10^{-10} 1×10^{-4}
cm	Angstrom units ft in. km m miles mm mils yd	1×10^8 3.281×10^{-2} 0.39370 1×10^{-5} 0.01 6.214×10^{-6} 10.0 393.70 1.094×10^{-2}
chains (surveyor's)	chains (engineer's) ft furlong in. links m miles	0.66 66.0 0.10 792.0 100 20.117 0.0125

Length (contd)

To Convert	Into	Multiply by
chains (surveyor's) (contd)	rods yd	4.0 22.0
fathoms	ft m	6.0 1.8288
ft	cm chains km m miles (statute) mm mils rods yd	30.4801 0.01515 3.048×10^{-4} 0.3048 1.894×10^{-4} 304.8006 1.2×10^4 0.06061 0.3333
in.	Angstrom units cm chains ft links m miles mm mils rods yd	2.540×10^8 2.540 1.2626×10^{-3} 0.08333 0.126263 2.540×10^{-2} 1.578×10^{-5} 25.40 1,000.0 5.0501×10^{-3} 2.778×10^{-2}
km	cm ft in. m miles mm yd	1×10^5 3,281.0 39,370. 1,000.0 0.6214 1×10^6 1,093.6
links (surveyor's)	chains cm ft in. links (engineer's) m miles rods yd	0.01 20.1168 0.66 7.92 0.66 0.201168 1.250×10^{-4} 0.04 0.22
m	Angstrom units chains cm fathoms ft in. km links miles (statute) miles (nautical) microns mm	1×10^{10} 0.04971 100.0 0.54681 3.2808 39.370 0.001 4.97096 6.219×10^{-4} 5.3961×10^{-4} 1×10^6 1,000.0

Length (contd)

Power (contd)

To Convert	Into	Multiply by	To Convert	Into	Multiply by
m (contd)	rods yd	0.198838 1.09361	Btu/min (contd)	watts	17.580
microns	Angstrom units cm in. m	1×10^4 1×10^{-4} 3.937×10^{-5} 1×10^{-6}	ergs/sec	Btu/min dyne-cm/sec ft-lb/min ft-lb/sec hp kg-cal/min kilowatts watts	5.688×10^{-9} 1.0 4.427×10^{-6} 7.3756×10^{-8} 1.341×10^{-10} 1.433×10^{-9} 1×10^{-10} 1×10^{-7}
miles (statute)	chains cm ft furlongs in. km links m miles (nautical) rods yd	80.0 1.609×10^5 5,280.0 8.0 6.3360×10^4 1.60935 8,000 1,609.35 0.8684 320.0 1,760.0	ft-lb/min	Btu/min ft-lb/sec hp kg-cal/min kilowatts watts	1.285×10^{-3} 0.01667 3.030×10^{-5} 3.239×10^{-4} 2.2597×10^{-5} 0.022597
millimicrons	Angstrom units cm m microns	10.0 1×10^{-7} 1×10^{-9} 0.001	ft-lb/sec	Btu/hr Btu/min hp kg-cal/min kilowatts watts	4.6263 0.077124 1.8182×10^{-3} 0.019433 1.356×10^{-3} 1.35582
mm	cm ft in. km m microns	0.1 3.281×10^{-3} 0.03937 1×10^{-6} 0.001 1,000.0	hp	Btu/min Btu/sec ft-lb/min ft-lb/sec kg-cal/min kilowatts watts	42.418 0.70696 3.30×10^4 550.0 10.688 0.7457 745.70
rods	chains ft furlongs in. links m miles yd	0.25 16.50 0.025 198.0 25.0 5.0292 3.125×10^{-3} 5.50	watts	Btu/hr Btu/min ergs/sec ft-lb/min ft-lb/sec hp joules/sec kg-cal/min kilowatts	3.4129 0.05688 1×10^7 44.254 0.73756 1.341×10^{-3} 1.0 0.01433 0.001
yd	chains cm ft in. km links m miles rods	0.04545 91.440 3.0 36.0 9.144×10^{-4} 4.5454 0.9144 5.682×10^{-4} 0.1818	atm	<u>Pressure</u> bars cm Hg (0° C) dynes/sq cm ft H ₂ O (4° C) g/sq cm in. Hg (0° C) kg/sq cm kg/sq m mm Hg lb/sq ft lb/sq in. tons/sq ft tons/sq in.	1.0133 76.0 1.0325×10^6 33.90 1,033.2 29.921 1.0332 10,332.0 760.0 2,116.2 14.696 1.058 0.007348
Btu/hr	ft-lb/sec g-cal/sec hp-hr watts	0.2162 0.0700 3.929×10^{-4} 0.2931			
Btu/min	ft-lb/sec g-cal/min hp	12.96 252.08 0.02356	bars	atm cm Hg (0° C)	0.98692 75.006

Pressure (contd)			Pressure (contd)		
To Convert	Into	Multiply by	To Convert	Into	Multiply by
bars (contd)	dynes/sq cm	1×10^6	kg/sq cm (contd)	lb/sq in.	14.223
	ft H ₂ O (4° C)	33.456			
	in. Hg (0° C)	29.5296	kg/sq m	atm	9.678×10^{-5}
	kg/sq m	10.197		bars	98.07×10^{-6}
	lb/sq in.	14.5038		dynes/sq cm	98.0665
	lb/sq ft	2,082.0		ft H ₂ O (4° C)	3.281×10^{-3}
cm Hg (0° C)				g/sq cm	0.10
	atm	0.013158		in. Hg (0° C)	2.896×10^{-3}
	bars	1.33322×10^{-2}		mm Hg (0° C)	0.073556
	dynes/sq cm	1.33322×10^4		lb/sq ft	0.2048
	ft H ₂ O	0.4461		lb/sq in.	1.422×10^{-3}
	kg/sq m	135.95	oz/sq in.	dynes/sq cm	4,309.2
	lb/sq ft	27.85		lb/sq in.	0.0625
dyne/sq cm	lb/sq in.	0.1934	lb/sq ft		
	atm	9.8692×10^{-7}		atm	4.725×10^{-4}
	bars	1×10^{-6}		bars	4.7880×10^{-4}
	cm H ₂ O (4° C)	1.01974×10^{-3}		dynes/sq cm	478.80
	g/sq cm	1.01971×10^{-3}		ft H ₂ O (4° C)	0.01602
	in. H ₂ O (4° C)	4.0148×10^{-4}		g/sq cm	0.48824
	in. Hg (0° C)	2.9530×10^{-5}		in. Hg (0° C)	0.01414
	kg/sq m	1.01971×10^{-2}	lb/sq in.	kg/sq m	4.8824
	lb/sq ft	2.0886×10^{-3}		mm Hg (0° C)	0.35913
	lb/sq in.	1.4504×10^{-5}		lb/sq in.	6.944×10^{-3}
	mm Hg (0° C)	7.5006×10^{-4}			
ft H ₂ O (4° C)	atm	0.02950	lb/sq in.	atm	0.06804
	in. Hg (0° C)	0.8826		bars	0.068947
	kg/sq cm	0.03048		cm Hg (0° C)	5.1715
	kg/sq m	304.8006		dynes/sq cm	6.8947×10^4
	lb/sq ft	62.426		ft H ₂ O (4° C)	2.3066
	lb/sq in.	0.43352		g/sq cm	70.307
g/sq cm				in. Hg (0° C)	2.0360
	atm	9.6784×10^{-4}		kg/sq m	703.07
	dynes/sq cm	980.665		lb/sq ft	144.0
	kg/sq m	10.0			
	lb/sq ft	2.0481			
	lb/sq in.	0.014223			
in. Hg (0° C)	mm Hg (0° C)	0.73556			
	atm	0.03342	<u>Time</u>		
	dynes/sq cm	3.3864×10^4	days (mean solar)	hr	24.0
	ft H ₂ O (4° C)	1.1329		min	1,440.0
	kg/sq cm	0.03453		sec	86,400.0
	kg/sq m	345.31	hr (mean solar)	days	4.167×10^{-2}
	lb/sq ft	70.73		min	60.0
	lb/sq in.	0.4912		sec	3,600.0
in. H ₂ O (4° C)				weeks	5.952×10^{-3}
	atm	2.458×10^{-3}			
	dynes/sq cm	2,490.82	min (time)	day	6.9445×10^{-4}
	in. Hg (0° C)	0.07355		hr	0.01666
	kg/sq cm	2.540×10^{-3}		sec	60.0
	oz/sq in.	0.5781		weeks	9.9206×10^{-5}
	lb/sq ft	5.204	months (mean)	days	30.42
kg/sq cm	lb/sq in.	0.03613		hr	730.0
	atm	0.9678		min	4.380×10^4
	dynes/sq cm	9.8067×10^5		sec	2.628×10^6
	cm Hg (0° C)	73.556			
	ft H ₂ O (4° C)	32.81	weeks	hr	168.0
	in. Hg (0° C)	28.96		min	1.0080×10^4
	lb/sq ft	2,048.1		sec	6.0480×10^5

Velocity

Velocity (contd)

To Convert	Into	Multiply by	To Convert	Into	Multiply by
cm/sec	ft/min	1.9685	miles/hr (contd)	km/hr	1.609
	ft/sec	0.03281		km/min	0.02682
	km/hr	0.0360		knots	0.8684
	knots	0.01944		m/min	26.82
	m/min	0.60		miles/min	0.01667
	miles/hr	0.02237	miles/min	cm/sec	2,682.2
	miles/min	3.728×10^{-4}		ft/sec	88.0
ft/min	cm/sec	0.5080		km/min	1.609
	ft/sec	0.01667		knots	52.104
	km/hr	0.01829		knots/min	0.8684
	knots	0.009868		miles/hr	60.0
	m/min	0.3048	<u>Volume</u>		
	m/sec	0.005080	acre-ft	cu ft	43,560.0
	miles/hr	0.01136		gal	3.259×10^5
ft/sec	cm/sec	30.480		cu in.	7.53×10^7
	km/hr	1.0973		cu m	1,233.49
	knots	0.5921	bd ft	cu cm	2,359.8
	m/min	18.29		cu ft	0.08333
	miles/hr	0.6818		cu in.	144.0
	miles/min	0.01136		cu m	2.3598×10^{-3}
km/hr	cm/sec	27.778	cords	cord ft	8.0
	ft/min	54.68		cu ft	128.0
	ft/sec	0.9113		cu m	3.625
	km/min	0.01667	cord ft	cords	0.125
	knots	0.5396		cu ft	16.0
	m/min	16.667	cu cm	bd ft	4.2376×10^{-4}
	m/sec	0.2778		cu ft	3.53144×10^{-5}
	miles/hr	0.6214		gal (US fluid)	2.642×10^{-4}
knots	cm/sec	51.48		cu in.	0.06102
	ft/hr	6,080.0		l	0.001
	ft/min	101.337		cu m	1×10^{-6}
	ft/sec	1.689		cu mm	1,000.0
	km/hr	1.8532		oz (US fluid)	0.033814
	m/sec	0.51479		pt (US fluid)	2.1134×10^{-3}
	miles			qt (US fluid)	1.0567×10^{-3}
	(nautical)/hr	1.0		cu yd	1.3079×10^{-6}
m/min	miles		cu ft	bd ft	12.0
	(statute)/hr	1.1516		cords	0.0078125
	cm/sec	1.6667		cord ft	0.0625
	ft/min	3.281		cu cm	28,320.0
	ft/sec	0.05468		gal (US fluid)	7.48052
	km/hr	0.060		cu in.	1,728.0
	knots	0.03238		l	28.316
m/sec	miles/hr	0.03728		cu m	0.028317
	cm/sec	100.0		pt (US fluid)	59.844
	ft/min	196.8		qt (US fluid)	29.922
	ft/sec	3.281		cu yd	0.03704
	km/hr	3.60	cu in.	bd ft	6.944×10^{-3}
	km/min	0.060		cu cm	16.38716
	knots	1.9425		cu ft	5.7870×10^{-4}
	miles/hr	2.2369		gal (US fluid)	4.3290×10^{-3}
	miles/min	0.03728		l	1.6387×10^{-2}
				cu m	1.6387×10^{-5}
miles/hr	cm/sec	44.704			
	ft/min	88.0			
	ft/sec	1.4667			

Volume (Contd)

Volume (Contd)

To Convert	Into	Multiply by
cu in. (contd)	cu mm	1.6387×10^4
	oz (US fluid)	0.5541
	pt (US fluid)	3.463×10^{-2}
	qt (US fluid)	1.732×10^{-2}
	cu yd	2.14335×10^{-5}
cu m	bd ft	423.76
	cords	0.2759
	cu cm	1×10^6
	cu ft	35.3144
	cu in.	6.1023×10^4
	l	1,000.0
	cu mm	1×10^9
	pt (US fluid)	2,113.4
	qt (US fluid)	1,056.7
	cu yd	1.3079
cu yd	cu ft	27.0
	gal (US fluid)	202.0
	cu in.	46,656.0
	l	764.54
	cu m	0.764559
	pt (US fluid)	1,616.0
	qt (US fluid)	807.9
gal	cu cm	3,785.4
	cu ft	0.13368
	cu in.	231.0
	l	3.785
	cu m	3.785×10^{-3}
	oz (US fluid)	128.0
	pt (US fluid)	8.0
	qt (US fluid)	4
	cu yd	4.951×10^{-3}
l	cu cm	1,000.0
	cu ft	0.03531
	gal (US fluid)	0.2642
	cu in.	61.02
	cu m	0.001
	oz (US fluid)	33.8147
	pt (US fluid)	2.113
	qt (US fluid)	1.057
	cu yd	1.308×10^{-3}
microliters	l	1×10^{-6}
ml	l	0.001
oz (US fluid)	cu cm	29.5737
	cu in.	1.80469
	l	0.02957
	pt (US fluid)	0.06250
pt (US fluid)	cu cm	473.179
	cu ft	0.01671
	gal	0.125
	cu in.	28.875
	l	0.4732
	cu m	4.732×10^{-4}
	oz (US fluid)	16.0
	qt (US fluid)	0.50

To Convert	Into	Multiply by
qt (US fluid)	cu cm	946.358
	cu ft	0.03342
	gal (US fluid)	0.25
	cu in.	57.749
	l	0.94633
	cu m	9.4633×10^{-4}
	pt (US fluid)	2.0
Weight		
gal H ₂ O (4° C)	kg H ₂ O	3.78533
	lb H ₂ O	8.34522
g	kg	0.001
	mg	1,000.0
	oz (avoirdupois)	0.03527
	oz (troy)	0.03215
	lb	2.205×10^{-3}
kg	g	1,000.0
	oz (avoirdupois)	35.2739
	oz (troy)	32.1507
	lb (avoirdupois)	2.2046
	tons (long)	9.842×10^{-4}
	tons (short)	1.102×10^{-3}
micrograms	g	1×10^{-8}
mg	g	0.001
oz (avoirdupois)	g	28.3495
	oz (troy)	0.91146
	lb	0.06250
lb (avoirdupois)	grains	7,000.0
	g	453.5924
	kg	0.4536
	oz (avoirdupois)	16.0
	oz (troy)	14.5833
	lb (troy)	1.2153
	tons (long)	4.4643×10^{-4}
	tons (short)	5.0×10^{-4}
lb H ₂ O	cu in.	27.68
	cu ft	0.01602
	gal	0.1198
tons (long)	kg	1,016.047
	lb	2,240.0
	tons (metric)	1.01605
	tons (short)	1.1200
tons (short)	kg	907.1848
	lb	2,000.0
	tons (long)	0.89287
	tons (metric)	0.9071848

Work; energy

<u>To Convert</u>	<u>Into</u>	<u>Multiply by</u>
Btu	ergs	1.0548×10^{10}
	ft-lb	777.97
	g-cal	251.98
	hp-hr	3.9292×10^{-4}
	joules	1,054.8
	kg-cal	0.25198
	kilowatt-hr	2.928×10^{-4}
ergs	Btu	9.4805×10^{-11}
	dyne-cm	1.0
	ft-lb	7.3756×10^{-8}
	ft-poundals	2.3730×10^{-6}
	g-cal	2.3889×10^{-8}
	g-cm	1.020×10^{-3}
	joules	1×10^{-7}
	kg-cal	2.3889×10^{-11}
	kg-m	1.020×10^{-8}
	kilowatt-hr	2.778×10^{-14}
	watt-hr	2.778×10^{-11}
ft-lb	Btu	1.286×10^{-3}
	ergs	1.356×10^7
	ft-poundals	32.174
	g-cal	0.32389
	hp-hr	5.050×10^{-7}
	joules	1.35582
	kg-cal	3.239×10^{-4}
	kg-m	0.1383
	kilowatt-hr	3.766×10^{-7}
g-cal (mean)	Btu	3.9685×10^{-3}
	ergs	4.1868×10^7
	ft-lb	3.0874
	ft-poundals	99.334
	hp-hr	1.5593×10^{-6}
	joules	4.186
	kg-cal	0.001
	kg-m	0.42685
	kilowatt-hr	1.1628×10^{-6}
	watt-hr	1.1628×10^{-3}

Work; energy
(contd)

<u>To Convert</u>	<u>Into</u>	<u>Multiply by</u>
kg-cal (mean)	g-cal (mean)	1,000.0
g-cm	Btu	9.297×10^{-8}
	ergs	980.7
	ft-lb	7.233×10^{-5}
	g-cal	2.3427×10^{-5}
	joules	9.807×10^{-5}
	kg-cal	2.343×10^{-8}
	kg-m	1×10^{-5}
hp-hr	Btu	2,545.0
	ergs	2.6845×10^{13}
	ft-lb	1.980×10^6
	g-cal	6.41190×10^5
	joules	2.684×10^6
	kg-cal	641.30
	kg-m	2.737×10^5
	kilowatt-hr	0.7457
joules	Btu	9.480×10^{-4}
	ergs	1×10^7
joules (contd)	ft-lb	0.7376
	g-cal	0.23889
	g-cm	1.0197×10^4
	hp-hr	3.725×10^{-7}
	kg-cal	2.3889×10^{-4}
	kg-m	0.1020
	watt-hr	2.778×10^{-4}
watt-hr	Btu	3.4130
	ergs	3.60×10^{10}
	ft-lb	2,655.3
	g-cal	860.01
	hp-hr	1.341×10^{-3}
	joules	3,600.0
	kg-cal	0.86001
	kg-m	367.10
	kilowatt-hr	0.001

Table 10.--Conversion of temperature from Fahrenheit to Centigrade

(In °C)

°F :	0 :	1 :	2 :	3 :	4 :	5 :	6 :	7 :	8 :	9 :
-30	-34.44	-35.00	-35.56	-36.11	-36.67	-37.22	-37.78	-38.33	-38.89	-39.44
-20	-28.89	-29.44	-30.00	-30.56	-31.11	-31.67	-32.22	-32.78	-33.33	-33.89
-10	-23.33	-23.89	-24.44	-25.00	-25.56	-26.11	-26.67	-27.22	-27.78	-28.33
-0	-17.78	-18.33	-18.89	-19.44	-20.00	-20.56	-21.11	-21.67	-22.22	-22.78
+0	-17.78	-17.22	-16.67	-16.11	-15.56	-15.00	-14.44	-13.89	-13.33	-12.78
10	-12.22	-11.67	-11.11	-10.56	-10.00	-9.44	-8.89	-8.33	-7.78	-7.22
20	-6.67	-6.11	-5.56	-5.00	-4.44	-3.89	-3.33	-2.78	-2.22	-1.67
30	-1.11	-0.56	0.00	0.56	1.11	1.67	2.22	2.78	3.33	3.89
40	4.44	5.00	5.56	6.11	6.67	7.22	7.78	8.33	8.89	9.44
50	10.00	10.56	11.11	11.67	12.22	12.78	13.33	13.89	14.44	15.00
60	15.56	16.11	16.67	17.22	17.78	18.33	18.89	19.44	20.00	20.56
70	21.11	21.67	22.22	22.78	23.33	23.89	24.44	25.00	25.56	26.11
80	26.67	27.22	27.78	28.33	28.89	29.44	30.00	30.56	31.11	31.67
90	32.22	32.78	33.33	33.89	34.44	35.00	35.56	36.11	36.67	37.22
100	37.78	38.33	38.89	39.44	40.00	40.56	41.11	41.67	42.22	42.78

Table 11.--Conversion of temperature from Centigrade to Fahrenheit

(In °F)

°C :	0 :	1 :	2 :	3 :	4 :	5 :	6 :	7 :	8 :	9 :
-30	-22.00	-23.80	-25.60	-27.40	-29.20	-31.00	-32.80	-34.60	-36.40	-38.20
-20	-4.00	-5.80	-7.60	-9.40	-11.20	-13.00	-14.80	-16.60	-18.40	-20.20
-10	14.00	12.20	10.40	8.60	6.80	5.00	3.20	1.40	-0.40	-2.20
-0	32.00	30.20	28.40	26.60	24.80	23.00	21.20	19.40	17.60	15.80
+0	32.00	33.80	35.60	37.40	39.20	41.00	42.80	44.60	46.40	48.20
10	50.00	51.80	53.60	55.40	57.20	59.00	60.80	62.60	64.40	66.20
20	68.00	69.80	71.60	73.40	75.20	77.00	78.80	80.60	82.40	84.20
30	86.00	87.80	89.60	91.40	93.20	95.00	96.80	98.60	100.40	102.20
40	104.00	105.80	107.60	109.40	111.20	113.00	114.80	116.60	118.40	120.20

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OXFORD: 111.84(083.5). KEY WORDS: meteorology, radiant energy, solar radiation, humidity, precipitation.

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NORTH CENTRAL FOREST EXPERIMENT STATION



50

1923

YEARS

1973